HOUSEHOLDS’ WATER USE DEMAND AND WILLINGNESS TO PAY FOR IMPROVED WATER SERVICES: A CASE STUDY OF SEMI-URBAN AREAS IN THE LUBOMBO AND LOWVELD REGIONS OF SWAZILAND

By

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A THESIS SUBMITTED TO THE FACULTY OF DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

LILONGWE UNIVERSITY OF AGRICULTURE AND NATURAL RESOURCES (LUANAR), BUNDA CAMPUS DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS

OCTOBER 2015
DECLARATION

I, Nqobizwe Mvangeli Dlamini, declare that this thesis is a result of my own original effort and work, and that to the best of my knowledge, the findings have never been previously presented to Lilongwe University of Agriculture and Natural Resources (LUANAR) or elsewhere for the award of any academic qualification. Where assistance was sought, it has been accordingly acknowledged.

Nqobizwe Mvangeli Dlamini

Signature: _________________________________

Date: _________________________________
CERTIFICATE OF APPROVAL

We, the undersigned, certify that this thesis is a result of the author’s own work, and that to the best of our knowledge, it has not been submitted for any other academic qualification within Lilongwe University of Agriculture and Natural Resources or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on 6th October, 2015.

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DEDICATION

This thesis is dedicated to my mother, Maggie Maphako and my late father, Zebron Dlamini (R.I.P).

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ACKNOWLEDGMENTS

First and foremost, I would love to thank God, the father of my Lord Jesus Christ for showing me favour before his eyes. I do believe that without his loving and forgiving mercy I wouldn’t have made it this far.

I would also like to acknowledge the contributions of the following, for which without their inputs I would have not completed this work; my sponsor, African Economic Research Consortium (AERC), for providing the necessary funding for my studies. Many thanks also go to my supervisor, Professor A. K. Edriss, for his patience, constant support and excellent guidance during my graduate studies at Lilongwe University of Agriculture and Natural Resources (LUANAR). Likewise, I owe many thanks to my co-supervisor, Dr. Charles B. L. Jumbe, Associate Professor, for his patience, guidance, enthusiastic encouragement and useful critiques of this thesis work. I would also like to extend my sincere gratitude to my other co-supervisor, Dr. M. B. Masuku, Associate Professor and Dean in the University of Swaziland faculty of Agriculture and Consumer Sciences. I am very grateful for his patience in nurturing me as a young man to what I have become. He believed in me even when I couldn’t believe in myself. For that, I am grateful and will forever cherish.

Many thanks to Dr. M.A.R. Phiri, Head of Department for Agricultural and Applied Economics in LUANAR, for affording me the opportunity to undertake my studies here at LUANAR. Many thanks also go to my other teachers and staff at LUANAR, Dr. L. P. Mapemba, Dr. M. Mwabumba and Prof. D.H.N. Ngongola, for providing me with a strong base in the field of economics. To all the other members of staff in LUANAR, from house cleaners, secretaries, drivers and accountants, am very grateful
for making my two year stay here in LUANAR a memorable one. Indeed, through your humility, Malawi is “the warm heart of Africa”.

I would also like to extend my thanks to Mr. B. Mdluli, from the Swaziland Water Services Cooperation (SWSC), Mr. S. Francesca from the European Union (EU) offices in Swaziland and Mrs. N. Ntshalintshali, from the Department of Water Affairs (DWA) for their assistance with relevant information used in the study. Finally, I am indebted to pass my gratitude to my entire family; my mother, my sister, my brothers, nephews and nieces for their words of encouragement and spiritual and financial support. Their mere existence made it possible for me not to give up even when the going got tough.
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<thead>
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<tbody>
<tr>
<td>ABM</td>
<td>Averting Behaviour Method</td>
</tr>
<tr>
<td>CBA</td>
<td>Cost Benefit Analysis</td>
</tr>
<tr>
<td>CS</td>
<td>Consumer Surplus</td>
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<td>CSO</td>
<td>Central Statistics Office</td>
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<td>CSU</td>
<td>Compensating Surplus</td>
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<td>CV</td>
<td>Compensating Variation</td>
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<td>CVM</td>
<td>Contingency Valuation Method</td>
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<tr>
<td>DBDC</td>
<td>Double-Bounded Dichotomous Choice</td>
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<tr>
<td>E</td>
<td>Emalangeni</td>
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<tr>
<td>ESU</td>
<td>Equivalent Surplus</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>EV</td>
<td>Equivalent Variation</td>
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<tr>
<td>GOS</td>
<td>Government of Swaziland</td>
</tr>
<tr>
<td>HPM</td>
<td>Hedonic Pricing Method</td>
</tr>
<tr>
<td>IIED</td>
<td>International Institute for Environment and Development</td>
</tr>
<tr>
<td>IWRM</td>
<td>Integrated Water Resource Management</td>
</tr>
<tr>
<td>MGD</td>
<td>Millennium Development Goals</td>
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<tr>
<td>SWSC</td>
<td>Swaziland Water Services Cooperation</td>
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TCM  Travel Cost Method
UNDP  United Nation Development Programme
VAC  Vulnerability Assessment Committee
WTA  Willingness to Accept
WTP  Willingness to Pay
ABSTRACT

This study was designed to assess household water demand and willingness to pay (WTP) for improved water services in the Lowveld and Lubombo regions of Swaziland. Using both purposive and cluster sampling methods, survey data were collected from 314 households in the month of April 2015, mainly in three constituencies, namely; Siphofaneni, Matsanjeni and Somnongtongo. The study used the Contingent Valuation Method (CVM) to estimate WTP using a double bounded dichotomous choice elicitation format. In assessing the determinants of WTP and water consumption, the study employed both the probit model and double-log regression model, respectively. Results from the study showed that about 67% of households in the study areas were willing to pay the initial bid offered for an improvement in their water services. Generally, about 93% of the sampled households were willing to pay something for the improvement in water services. The study further showed that the estimated mean WTP for a 20 litre of water was E0.47\(^1\). On household water demand, results showed that the mean daily per capita water consumption was 13.12 litres. Results from the probit model showed that household income, education, gender, distance and owning a backyard garden positively and significantly affect WTP. Furthermore, age, water quality and the initial bid offered negatively and significantly affected WTP for improved water. On the other hand, results from the double-log regression model showed that education, household income and ownership of a water tank were positive factors influencing household water consumption. In addition, household size, distance and years of using source were negative determinants of household water consumption. The implications of the study are that factors such as age, income, level of education, gender, distance and

\(^1\) 1 USD = E13.5 Emalangeni

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household size should be considered when setting domestic water tariffs and designing strategies on demand management.
CHAPTER ONE
INTRODUCTION

1.1 Background

The provision of safe and clean water to the rural and semi-urban areas of Swaziland holds an enormous potential of uplifting livelihoods. As pointed by Okun (1988), improved access to clean and safe water supply is closely linked to improved economic wellbeing. The clear interdependence between water availability and development is exemplified by the link between water and poverty (Coster and Otufale, 2014). Similarly, the Swaziland Poverty Reduction Strategy and Action Plan (PRSAP) identified the inefficient access to safe and clean water as the core cause of poverty in Swaziland, which has to be addressed immediately (Government of Swaziland [GoS], 2007). According to the 2013 annual Vulnerability Assessment Committee (VAC) report, it is estimated that about 62% and 64% of the total population have access to improved water sources during dry and rainy seasons, respectively (GoS, 2013). In line with Millennium Development Goal (MDG) number 7 and national targets, the country aspires to supply all communities with clean water by 2015 and as well as safe, affordable and acceptable drinking water for all by 2022 (Nazarene Compassionate Ministries [NCM], 2013).

However, water resources in recent years have been under stress owing to substantial growth in human populations (International Institute for Environment and Development [IIED], 2012). Increases in human populations imply substantial increases in the demand for food and other social services. This has been no different to Swaziland as a number of scholars have recognized that local water supply is beyond sustainable supply (Peter and Nkambule, 2012; Farolfi et al., 2007). In a
resource economics perspective, the water resource is being over extracted, while it is also not being efficiently allocated. For the same reason, economists have been advocating the idea of attaching a monetary value to water which potentially can improve sustainable use (Hanemann, 1994; Chandrasekaran et al., 2009) and thus maximise economic and social welfare in an equitable manner.

According to Pearce (1993), important conservational strategies and projects are rightfully addressed when monetary prices are identified. However, in contrast, traditionally water in rural communities has been assessed as a non-market good from natural sources like rivers, wells, lakes and dams, which are shared by both humans and animals. This usage amid of population pressures has had severe implications not only on humans but also on the environment. Water degradation and contamination have resulted mainly because of over exploitation, and because of poor sanitation, ground water gets contaminated too. Such situation has left most households to rely on government-provided community water schemes to supply clean water to the rural and semi-urban populations. This reliance has been further exuberated as some of the traditional sources have run dry or contaminated leaving rural residents to travel long distances for water.

Swaziland is divided into four ecological zones: the Highveld, Middleveld, Lowveld and Lubombo Plateau. Due to droughts in recent years, many areas of the country are facing aggravatated water scarcity. The dry parts of the Lowveld and Lubombo regions are examples of such areas where water scarcity has inflicted injuries on the social and economic lives of the populace (Mijinyawa and Dlamini, 2008). As a result, government efforts to supply water through community taps or boreholes have
focused mainly in these areas in recent years (GoS, 2013). These efforts, however, have not been successful mainly because water discharged from these sources are of very low quantities and the sources get desiccated during dry seasons (Mijinyawa and Dlamini, 2008). Moreover, where these sources are relatively reliable, water produced is of compromised quality. These communities rely only on these sources as their main primary source of potable water and the secondary source of buying water from water vendors at inflated prices further pushes them to a severe poverty trap.

To address this problem, the European Union (EU) through the Government of Swaziland (GoS) and Swaziland Water Service Cooperation (SWSC) has funded a water project to supply communities in these areas, mainly in Matsanjeni, Somnotongo and Siphofaneni, with clean treated water and sanitation services through commercialization of water services. Water will be sold in kiosks for households that cannot afford a private water connection, while those affording, private connection will be made and meters installed for monthly payments. However, a socially acceptable price to be charged relative to these communities is unknown as this is a project of its first kind in rural communities. The importance of setting a ‘socially efficient’ price is justified by the fact that an exaggerated price of water can further push households to severe poverty while a very low price can cause unsustainable demand to water, a resource already under stress.

As such, a thorough investigation on the extent to which households are willing to pay for improved water services and the amount they are willing to pay is of great importance. Firstly, such knowledge will enhance water managers to understand the demand side for improved water services in these areas. Secondly, this will allow
water managers to know if households in the study areas are capable of paying a price of water which can ensure sustainability of the project without compromising rural livelihoods. Lastly, this can also help policy makers in setting targeted subsidies on poor households. Therefore, the purpose of this study is to estimate Willingness to Pay (WTP) for improved water services and household water demand in the semi-urban areas of the Lubombo and Shiselweni regions, which can potentially improve the understanding of the demand side for improved water services in these areas.

1.2 Problem Statement

Most rural households spend a lot of time collecting water due to non-functioning of community water schemes. This forces poor households to travel long distances to access water from unhealthy sources like wells and rivers (Mijinyawa and Dlamini, 2008). Where functional, queues are an inevitable problem as these water projects supply quite a substantial number of households. Such long queues divert valuable time from numerous economically productive activities for the poor (IIED, 2009). Also as noted by Ainuson (2009), staying in long queues for a long time at water provision centres is a source of tension and often leads into conflicts. Such conditions force these poor households to use unsafe alternatives of water sources like rivers and dams. Consequently, this result in high levels of water borne diseases and hygiene problems, which leads to high mortality rates, increased health costs and reduced labour productivity to the poor.

The idea of a potential Pareto improvement thus provides the rationale for public intervention to increase the efficiency of resource allocation (Haab and McConnell, 2002). Therefore, the government and affected parties are faced with an urgent task of
supplying clean water to rural communities in an effort to uplift rural livelihoods. Decisions on water allocation in Swaziland, however, are currently taken on the basis of very limited information. Thus, environmental valuation attempts to quantify the benefits of environmental or public projects and policies, so that they are more transparent, and can be given due and appropriate weight in any decision making process or cost benefit analysis (CBA) (Garrod and Willis, 1999). Based on resource economics theory, government is justified to provide improved water services if the unit cost of establishing one is equal or less than the value the community attach to such a service.

However, lack of knowledge on rural household’s WTP for water services exists in the rural areas of Swaziland. This further discourages both government and private interest on establishing more water sources as there is no evidence whether such projects can be successful or sustainable. Moreover, these community water projects put pressure on government expenditures making government unable to expand water supply to other equally poor communities facing aggravated water scarcity. Therefore, as noted by Kanyoka et al. (2008), financially viable rural water projects should come as a form of partial coverage from communities through the introduction of water fees. It is, therefore, important to determine the non-market value rural communities attach to such water services for efficient resource allocation.

As already stated, there exists a negligible literature on households WTP for household water and water demand in Swaziland. Most researchers have been focusing on the impacts and sustainability factors of community water schemes (Peter and Nkambule, 2012; Ndwandwe, 2005; Manyatsi and Mwendera, 2007). According
to the author’s knowledge, a study by Farolfi et al. (2007) estimated domestic water use and values in Swaziland. However, as pointed out by a number of researchers, WTP for water varies from time to time and from location to location (Rogerson, 1996; Gunatilake and Tachiiri, 2012). Therefore, the study aims at estimating WTP for improved water services in the semi-urban areas of Swaziland which is important for evaluating policy alternatives, setting socially acceptable water tariffs and for cost recovery purposes.

1.3 Objectives

The main objective of the study is to estimate willingness to pay for improved water services among households in the study areas.

**The specific objectives of the study are to:**

i. Quantify WTP for improved water services and household water use demand.

ii. Estimate the parametric mean WTP for improved water services.

iii. Determine the factors affecting WTP for improved water service.

iv. Assess the factors affecting per capita water consumption.

1.4 Hypotheses

Based on a survey of literature the study forms the following hypotheses;

i. Households without a nearby or private water source do not have a higher WTP than their counterparts with such.
ii. Similarly, households who travel shorter distances to collect water do not consume more water per capita than their counterfactuals that travel longer distances.

iii. Households with higher incomes will not demand more improved water services as they are probably consuming such. Therefore, it is hypothesised that income will affect WTP negatively.

iv. Socio-economic variables like age, education, household size, gender, marital status and social position, do not affect households’ WTP for improved water services and household water consumption.

v. Households which already have enough water have no incentive to pay more for improvement in quantity. That is, households already consuming higher levels of water may not be willing to pay for an improvement in their water services.

**1.5 Research Questions**

The study aims at answering the following questions:

i. Are households in the study areas willing to pay for improved water services and how much are they willing to pay?

ii. What factors influence household per capita water consumption and WTP for improved water services in the study areas?
1.6 Justification

A more comprehensive knowledge of the structure of water demand both through survey utility data and stated preference methods can help to better understand consumer behaviour. As noted by Nauges and Whittington (2010), management of water resources in an equitable manner by water managers has proved to be a demanding task. Therefore, evaluating domestic water demand behaviours produces an underlying basis for water managers to sustainably and efficiently meet the ever increasing demand for water. Likewise, knowledge on how socio-economic characteristics influence responsiveness of water demand to price and non-price factors provides appropriate policy information on household demand characteristics (Strand and Walker, 2005).

As such, Swaziland’s ‘Vision 2022’ with respect to the water sector seeks to attain a 100% supply of safe, affordable and acceptable drinking water for all. Achieving such a goal requires relevant information regarding households’ water demand behaviours and the factors that influence WTP for improved water services. As noted by Whittington et al. (1991), it is important to conduct studies which help in understanding water use and its dynamics at household level as it enhances informed decision making amongst water managers. This study is, therefore, timely and can contribute in achieving the targets set for water coverage by providing relevant household level information.

Furthermore, in light of the proposed EU water project, the unavailability of information on households WTP for improved water services and water demand characteristics in the study areas further justified the need to conduct the study. The
study will potentially contribute in setting a socially acceptable price and further provide an understanding on the demand for household water in these areas. It is, however, worth mentioning that WTP is not a measure for price (Banda et al., 2006). However, the results from the study can be used in CBA when determining whether the project is worth implementing (Bateman et al., 2002). Therefore, the study aims to assess households’ WTP for improved water services and water demand in an effort to provide important information for improving water accessibility.

1.7 Organisation of the Study

The study is organized into five chapters. After this chapter, Chapter two provides an extensive review of literature, from the theoretical foundations of welfare change to reviews of related empirical literature on WTP for water services and household water demand. Chapter three presents a detailed description of the conceptual, theoretical and empirical frameworks adopted in the study. The chapter also includes a description of the study areas, sampling size and sampling techniques adopted. Chapter four presents descriptive analysis from the survey data and also discusses the empirical findings of this study. Finally, chapter five presents a summary of findings, conclusions and recommendations from the study.
CHAPTER TWO
LITERATURE REVIEW

2.1 Valuation of Natural Resources

Economic valuation of environmental and natural resources entails assessing the preferences of society with regards to an environmental resource or public good. It is a method used for assigning monetary value to the outcomes of choices about policies, projects and programmes (Bateman et al., 2002). Valuation of natural and environmental goods has grown importance in recent years. This has been mainly due to efforts by governments to increase resource allocation efficiency and sustainability in the face of increased human pressures. Moreover, natural resources are also resources such as labour and capital; therefore, it is important that they are appropriately and sustainably managed. According to Pearce (1993), important conservational and sustainable strategies for natural resources and public projects are rightfully addressed when economic values are identified.

Most natural resources and public goods are provided freely and thus have missing markets. In light of missing markets, resources are mismanaged and inefficiently allocated due values of goods and services being not revealed (Kadekodi, 2001). At times where markets exist, inefficiencies may still occur due to improper regulated markets. Water generally is one good which is under-priced due to its public good characteristics. According to Whittington et al. (1991), such kinds of environmental or public goods are the main causes of externalities. Consequently, markets cannot efficiently allocate such goods with pervasive externalities, or for which property rights are not clearly defined (Haab and McConnell, 2002). Therefore, in solving for
externalities, it is important that economic values are attached to such public goods. Valuation of natural resources like water therefore, reveals the economic value or benefits individuals derive from their services for proper management (Whittington, 1998).

There are quite a number of economic methods used in valuing public or environmental goods and they specifically belong to two categories. In the first category are those which depend on observed human behaviours and thus derive inferences about preferences and economic values from such behaviours. The second category is those which rely on stated or revealed preferences by individuals. The main valuation techniques between these categories are hedonic and travel cost methods for the first category and while the second category consist of choice modelling and contingent valuation methods (Haab and McConnell, 2002). According to Tietenberg and Lewis (2012), the first category represents those involving observed behaviour and the second category as one involving hypothetical behaviour. Revealed preference method includes Hedonic Price Method (HPM) and Travel Cost Method (TCM) while stated preference includes the Contingent Valuation Method (CVM) and Choice Modelling (CM). This study uses the CVM to evaluate the non-market value of improved household water services.

2.2 Theory of Welfare Change

The basic foundation of the theory of welfare economics is to increase the wellbeing of an economic agent or individual in any economic activity. Previously, most studies have looked into the welfare effects of prices consumers pay for goods sold in the
market without much consideration on environmental goods. According to Mitchell and Carson (1989), economic values of environmental goods are measured using their effects on human welfare. Therefore, estimating economic values of environmental or public goods is an attempt to measure the impact and/benefits these goods bring to individual utilities.

Changes in environmental or public goods can affect people’s welfare in any of the following four different ways. Firstly, such changes can affect individuals through the prices they pay for goods in the market. Secondly, this also can affect and cause changes in the prices individuals pay for their factors of production. Thirdly, environmental changes can also affect individuals through changes in quality and quantities of other public goods. Finally, a change in environmental or public good can induce changes in risks individuals face (Freeman, 2003). In the case of this study, an improvement in community water services can lower money spent on market goods such as those for averting behaviours. Secondly the water project can also lower the price of water currently used for production purposes. Lastly, the improvement can induce sanitary in the community thus improving clean scenery and improved clean air which concurrently can lower the risks of infections and child mortality.

The central concern on policy makers is to measure among alternative public resource allocation decisions to improve social welfare. A more appropriate welfare measure for policy in the provision of public goods or resource allocation is the use of Pareto improvement, a gain to one person without making any other one worse off. The idea of a Pareto improvement lies on the basis that overall benefits of a public intervention
should exceed the costs of that intervention. In this context, resource allocation can achieve greater efficiency. According to Perman et al. (2003), an allocation of resources is said to be efficient if it is not possible to make one or more persons better off without making at least other person worse off, allocative efficiency. Likewise, an allocation is inefficient if it is possible to improve one’s welfare without worsening anyone else. Thus, Pareto improvement is not a sufficient but a necessary condition for achieving allocative efficiency in environmental or public provisions of goods, a state where no further improvements are possible without worsening ones welfare.

Conventionally, welfare changes from changes in environmental or public goods have been estimated using Consumer Surplus (CS), the area under the Marshallian (ordinary) demand curve above the price level. These demand functions are derived through utility maximization. Consumers are presented with a problem of maximizing utility subject to an income constraint. Solving the utility maximization problem leads to a set of ordinary demand functions as functions of prices and income.

There have, however, been concerns about the use of CS as a welfare measure due its inefficiency in keeping utility constant. In addition, environmental (or public) goods have a particular characteristic that makes the concept of the Marshallian demand function and CS difficult to be applied. The absence of a price for environmental or public goods makes them untradeable as they do not have private property characteristics. Therefore, one cannot directly observe the price and other information required to estimate the Marshallian demand curve. Even though it is possible to approach this problem using, for example, a surrogate market, the accuracy of CS is often disrupted by the presence of income effect (Bateman and Turner, 1992).
Furthermore, environmental or public goods usually have much higher income elasticities than market goods (Bateman and Turner, 1992). Accordingly, the welfare’s change measurement using CS may be undermined. Therefore, it is important to use a more accurate welfare measure that is free from ambiguity.

To address this ambiguity, Hicks (1943) developed four alternative welfare measures as a refinement of the ordinary Marshallian demand functions. The use of the Hicksian compensating welfare measures assumes that consumer’s utility level remains the same as before the change in the supply of environmental services (Nicholson and Snyder, 2008). Given the ordinary demand function, formulating the duality of the maximization problem derives the expenditure function. An individual is, therefore, assumed to minimize expenditure subject to a given level of utility. Solving the minimization problem leads to the Hicksian demand functions which shows the quantities consumed at various prices assuming that income is adjusted, so that utility is held constant (Freeman, 2003). The four alternative welfare measures which are a refinement of the ordinary CS are discussed as follows;

*Compensating Variation (CV):* CV is defined at initial utility level with price changes. If there’s a price decrease, CV is the adjustment of an individuals’ income needed so to keep him/her at the initial utility level as without the price decrease, maximum WTP. Similarly, given a price increase, CV is defined as the amount of money that is required by the consumer to keep him/her at the same utility level as without the price increase, minimum Willingness to Accept (WTA) (Markandya et al., 2002). CV analysis is used when we attempt to fix some compensating scheme at new
price levels, for that, CV thus uses different base prices for each new policy change (Varian, 1992).

Equivalent Variation (EV): EV is defined at the new level of utility with price changes. With a price decrease, EV is defined as the additional income to be given to the consumer to bring him/her to the same level of utility she/he would attain with the current income if the price decreases, minimum WTA in place of the price decrease. Similarly, with a price increase, EV is defined as the amount of money to be taken away from the consumer to bring him/her to the same level of utility s/he would attain with the current expenditure if the price increase occurred. It measures the individual’s maximum WTP to avoid the price increase (Markandya et al., 2002). EV may be better alternate if we are going to compare more than one proposed policy change because EV keeps base price at status quo (Varian, 2010).

Compensating Surplus (CSU): CSU is defined at initial utility level with changes in quality or quantity. For an improvement, CSU is defined as the amount of money that needs to be deducted from the income of the consumer to keep him at the same utility level as without the environmental improvement, maximum WTP. Similarly, with degradation, CSU is defined as the amount of money to be given to the consumer to keep him/her at the same level of utility prior to the environmental damage, minimum WTA.

Equivalent Surplus (ESU): ESU is defined at the new level of utility with changes in quality or quantity. Given an improvement, ESU is defined as is the additional income to be given to the consumer to bring him/her to the same level of utility that she/he
would attain with the current income given the environmental improvement, minimum WTA. Likewise, with degradation, ESU is defined as the amount of money to be taken away from the consumer to bring him/her to the same level of utility she/he would attain with the current income if the environmental damage occurred, maximum WTP to avoid the degradation (Markandya et al., 2002).

2.3 Contingent Valuation Method (CVM)

Also known as a stated preference approach, the CVM is a non-market valuation method used to value public and environmental goods. It involves asking a sample or population of interest for willingness to pay or willingness to accept (Perman et al., 2003). This method has been used in recent years to establish individuals’ preferences in light of an absent, incomplete or imperfect market for a good (Fujita et al., 2005). Therefore, the CVM attempts to elicit non market valuation of eco-systems by questioning respondents directly for their maximum WTP or WTA for a change in environment quality (Wilson and Carpenter, 1999). The method is thus “contingent” in the sense that WTP is asked contingent on certain hypothetical scenario.

The CVM is called ‘contingent’ valuation because it uses information on how people say they would behave given certain hypothetical situations, contingent on being in the real situation (Whitehead and Blomquist, 2006). According to Arrow et al. (1993), the CVM is a valuation based on carefully designed and administered sample surveys which creates a chance for participants to evaluate a public or nonmarket good. Mitchell and Carson (1989) suggest that CVM is the more common and appropriate valuation technique used in the valuation of public goods. These hypothetical market
exercises can provide valuable information about the characteristics of the demand for a good which is not traded presently (Mitchell and Carson, 1989).

Historically, the CVM dates back to 1963, when it was published for the first time by Davis (1963) in the study of hunters and tourists. From then, the CVM has grown in importance and has been utilized in to measure various environmental goods like, wetlands, recreational parks, wild life reserves, air and water quality, game parks, etc. The earlier use of the CVM however by most researchers was mainly based on use values, but as the theory of non-use was introduced, the CVM was extended to estimate both (Hoehn and Randall, 1987). CVM as a stated preference method thus can also derive information about people’s preferences which cannot be observed through individual action, like non-use values.

With a strong foundation in constrained utility maximization theory (McFadden, 1974) stated preference technique has become the most widely used tool for estimating benefits associated with providing non-marketed goods and services, especially in environmental economics literature. The CVM has, as highlighted by Carson et al. (1999), the flexibility of measuring both use and non-use values of a variety of goods. It is for this reason that the CVM has been used beyond the convectional environmental goods. Recently, the CVM have been utilized in the fields of health economics to measure peoples WTP to avoid certain health measures like obesity (Smith, 2000; Cawley, 2008). Another study by Damigos et al. (2009) used the CVM to estimate peoples’ WTP for improved energy security.
The goal of a CVM is to quantify compensating and equivalent variation of a resource or environmental quality. Compensating variation is more appropriate when the respondent is required to pay for the good, like paying for an enhancement in water quantity. On the other hand, equivalent variation is mainly used when the respondent might potentially lose the good, thus it is the minimum compensation that the individual will accept in lieu of the loss (Perman et al., 2003). Both techniques can be elicited by asking the WTP/WTA from the respondents.

### 2.3.1 Contingency Valuation Formats

CVM mainly relies on stated preferences from respondents; there are a number of formats for eliciting WTP or WTA. One traditional method is the “Open-ended” elicitation format which entails asking respondents the maximum amount of money they are willing to pay or accept without any referendum. With advantages like being quick to administer and avoiding the “anchoring effect”, this method has proved not to be in line with economic theory. According to Arrow et al. (1993), asking respondents about WTP using an open-ended format presents them with a difficult task. Respondents often find it difficult to ascribe an economic value of a non-market good instinctively and therefore needs some form of reference point to bound value judgement (Wattage, 2001).

Moreover, this elicitation technique has proved to result in high non-response rates (Desvousges et al. 1983) and large numbers of questionably high or low values (Cho et al., 2005). In an attempt to improve the CVM elicitation format, researchers have introduced the following elicitation formats.
✓ Checklist (Payment card) format
✓ Bidding game format
✓ Dichotomous discrete choice
✓ Dichotomous discrete with follow up question

In recognition of the bias from the open ended format, Mitchell and Carson (1981) introduced the “payment card” method which involves asking WTP or WTA question from respondents by providing them with a range of estimates from which to choose. This method is more cumbersome than the open ended method as it presents several problems. Although improving the number of non-protest answers and outliers, this method has brought concerns like anchoring effects, decisions of bids used and the size of the intervals in the values (Cameron and Huppert, 1989). The method justifies its use by that unlike the bidding and dichotomous methods; the payment card avoids the “starting point” bias while also providing a reference point to the respondent.

Used in the first published CVM study by Davies (1963), the “bidding game” method involves presenting an initial value to respondents and asking if they accept then iterate higher or lower depending on the response through bidding. The interviewer iteratively changes the stated amount of money to be paid or received until the highest amount the respondent is WTP, or the lowest amount the respondent is WTA is precisely identified (Wattage, 2001). An upward iteration will mean yes to initial bid offered and likewise downward iteration mean the respondent responded by a no on the initial bid. Although not avoiding the starting point bias, the bidding game has
shown to likely produce maximum WTP or WTA values from respondents than the other methods (Cummings et al., 1986).

The third method is the “dichotomous discrete choice” method which was developed by Bishop and Heberlein (1979) and this involves a take-it or leave-it kind of format. Respondents are simply asked on whether they are willing to pay or accept a certain amount given a scenario. The main improvement of this method compared to the other methods is that it abridges the respondent's task in a fashion similar to the bidding game without going through the iterative process. Moreover, the respondent, just like any other consumer, has only to make a judgement about a given price (Wattage, 2001). The method still suffers the starting point bias while it also needs large sample sizes and proper model specifications for statistical precision on WTP estimate (Cameron and Huppert, 1989).

The above methods have been shown to suffer from compatibility problems in which survey respondents can influence potential outcome by revealing values other than their true willingness to pay. Therefore, the discrete “dichotomous double bound” method was introduced in an attempt to increase precision on estimates. This method was originally developed by Hanemann (1985) and mainly involves questioning respondents two yes or no WTP questions where the bid price in the second or follow-up question is higher (lower) if the answer to first question is positive (negative). This method has shown to produce more efficient estimates than those from a single question (Hanemann et al. 1991).
In spite of the potential bias the double bound CVM comes with, it has been noted that the method is justified as it produces lesser mean square error which in-turn leads to more conventional WTP estimates by lessening the confidence interval of the WTP measures (Alberini, 1995). As the incentive incompatibility bias is mainly controlled by using the WTP estimates from the first bid, anchoring effect bias can be moderated by making sure that the first proposed bid to the respondent is as close to the actual but unobserved WTP as possible. It is therefore, for the same reasons the study uses the dichotomous double bound with a follow up question to estimate WTP for improved water services.

2.3.2 Contingency Valuation Biases

The CVM has been vastly used in the economic valuation of a number of environmental and public goods. However, regardless of the substantial use and improvements conducted along the years, the CVM is still subject of great controversy and suffers major criticisms with regards to the biases the method comes with. The CVM suffers from a range of biases in terms of theoretical and practical situations given its nature of technique and the survey instrument. Detractors of the CVM argue that respondents give answers that are inconsistent with the principles of rational choice (Arrow et al., 1993).

Through these biases, there are critics of the CVM method who feel the method is fundamentally imperfect (Diamond and Hausman 1994). Scott (1965) criticised the CVM and concluded that “ask a hypothetical question and you get a hypothetical answer”. Proponents to the CVM however, have shown that validity and reliability of a CVM lies mainly on a carefully planned and articulated study (Arrow et al. 1993;
Carson et al. 2001; Gunatilake et al. 2006). Thus through its usefulness, according to Boardman et al. (2006), the CVM is nowadays very much broadly acknowledged and most importantly used to valuate public goods such as water. Following Kristom (1990), the biases of CVM are conservatively classified as follows;

2.3.2.1 Strategic Behaviour Bias

Strategic behaviour in economics is closely related to utility maximization behaviour. This is because, based on neoclassic theory, 'rational' individuals as essentially selfish (Bateman and Turner, 1995). Therefore, strategic behaviour represents some sort of free riding as the respondent is faced with a prisoner’s dilemma, not knowing whether the next person will contribute or receive. Thus, strategic behaviour occurs when the respondent’s maximum WTP/WTA response does not represent an honest preference revelation. A respondent may feel that contributions from other members of the community may be enough to supply an improved community water scheme and can thus understate WTP. Similarly, if a respondent is keen on the improved community water and understands that such provision depends on mean WTP, he/she may overstate WTP.

2.3.2.2 Hypothetical Bias

The CVM technique is a method ‘contingent’ on a hypothetical scenario presented to respondents. However, if respondents are not familiar with presented scenario, in our case being an improved community water service, their WTP for the service may not represent true WTP. It is, therefore, important to present a scenario which respondents will fully understand and be realistic for respondents to take seriously (Whittington,
1987). According to Brookshire et al. (1980), the best way of minimizing hypothetical bias is making the scenario as credible as possible.

### 2.3.2.3 Starting Point Bias and Anchoring effect

This form of bias occurs when the initial bid presented to a respondent may influence the value of WTP. The main methods presenting this bias are both the bidding game and dichotomous choice as they present starting bids. Therefore, this may cause WTP to deviate from the true WTP. One method to reduce influences of this kind of bias has been the use of the payment card method. However, the payment card method has also been identified as to present the “anchoring effect” of bids within the range given on the card. Thus, this suggests to respondents that such range contains the “real” value of the good (Hanemann, 1985).

### 2.3.2.4 Payment Vehicle Bias

This form of bias emanates from the fact that the method of payment presented to respondents may influence the amount of WTP by the respondent. A payment vehicle like increasing taxes may not affect unemployed respondent and, therefore, the respondent may overstate WTP. Similarly, a working respondent may understate WTP due to the payment vehicle of increased taxes. Mitchell and Carson, (1989) points out five considerations for a good payment vehicle and these are; familiarity, credibility, empathy, feasibility and universality. Therefore, to minimize the effects of a payment vehicle bias from respondents, the features highlighted above should be included as considerations of a good payment vehicle.
2.3.2.5 Interviewer Bias

This bias occurs when the character of the interviewer influences the respondent’s to accept to pay a given amount. The respondent may attempt to please the interviewer by overstatement WTP or the interviewer might lead the respondent towards the amount he/she is expecting. In order to minimize the interviewer bias, Carson et al. (2001) suggests using well trained and neutral interviewers. It is for the same reason that the study uses university students to collect data for the study.

2.3.2.6 Information Bias

Due to the nature of a CVM as a stated preference method, information provided to a respondent is a key factor in revealing unobserved but true WTP. Mitchell and Carson, (1989) conducted a study and split the sample into two groups that were given different information. Even though there was no statistical differences, results from the study showed that mean WTP increased with additional information. Therefore, to ensure that information bias does not supersede, it is key “…to ensure that such information is seen to be true, constant across the sample, and not designed to induce bias towards a particular result, polemic and implicit value judgements being inadmissible” (Bateman and Turner, 1995).

2.4 Empirical CVM literature on water

There exists an excess of studies using the CVM method in eliciting the value of water resources for both household and commercial use. Whittington et al. (1990) used the CVM to estimate WTP for water services in Laurent, rural areas of Haiti. The researchers used the bidding game as an elicitation method mainly to avoid the “anchoring effect”. They found that respondents are willing to pay US$1.14 per month
for improved water. In estimating the value of irrigation water in Homna, a district in Bangladesh, Akter (2007) used the CVM to gather farmers WTP for irrigation water. The study used irrigation charges per decimal of land area per cropping season as the payment vehicle. Results from the study showed that mean WTP was at US$27.83 per season. The study further revealed that the variables age, level of education, household size, number of income sources and ownership of farmland are significantly related to WTP.

In Pakistan, Khan et al. (2010) using the CVM method conducted a study on willingness to pay for improved quality of drinking water. The study use a sample size of 150 randomly selected households and employed both the multinomial logit and linear regression (OLS) model for households averting behaviours and WTP, respectively. Results from the study revealed that WTP for improved drinking water was significantly determined by income, level of education and households’ awareness/exposure to mass media. Banda et al. (2006) also used the CVM to quantify and analyse the relationship between WTP for improved water availability and quality, and the current water availability status in the urban and rural areas of South Africa Steelpoort sub basin. The researchers employed the tobit model to analyse the factors affecting WTP. Results showed that WTP is affected by monthly water consumption, income, water availability and access to tap water.

In Swaziland, Farolfi et al. (2007) used the CVM to study the determinants of WTP for improved domestic water quality and quantity. A sample size of 343 households was surveyed both in rural and urban areas and a tobit model to explain household preferences to quality and quantity was used. Results showed that household income,
time for water collection, age and gender (female) were significantly and positively associated with WTP for improved quantity. Water consumption and source were also significant, however, with a negative sign. This implies that the more a household consumes water the less the value of WTP for an improvement in quantity. Similarly, households with private water consumption were willing to pay less for more quantities. On improvements in water quality, the study showed that location (rural households), households which practiced avoidance measures, water consumption, household income and current water source were all positively and statistically significant to WTP.

Estimating the economic value of irrigation water in Ethiopia, Wondo Genet District, Mezgebo et al. (2013) used the CVM in eliciting WTP values. The researchers surveyed 154 households in the area and used both the probit and bivariate probit to determine factors affecting WTP decision and mean WTP, respectively. The study used personal interviews and the elicitation format used was both the double bounded dichotomous choice and open ended elicitation formats. Results from the probit model showed that income, age, cultivated land, initial bid, awareness and education level were significantly related to WTP decision. The researchers from the study further concluded that policy should target double bounded elicitation formats than open ended formats as results showed that WTP for the latter was less than that of the former.

In rural Uganda, Wright (2012) used the CVM to conduct a study on WTP for improved water sources in the villages Kigisu and Rubona. Data from the study were collected from 122 households out of a population of 400 households in the villages.
The researcher used the iterative bidding process in eliciting WTP and further employed an ordered probit model to determine the influences of WTP. The study estimated mean WTP at 286 Ugandan Shillings (UGX) for a 20 litres of public tap water and 202 UGX for a 20 litres of private tap water. On the determinants of WTP, the study reported that the number of children and distance from the water source were positively and significantly influencing households WTP. This means as the number of people in a household increase the more the household will be willing to pay more for water. Likewise, the longer the distance from the water source a household is, the more the probability that the household is willing to pay.

Ogunniyi et al. (2011) also used a CVM in Kwara state in the western part of Nigeria to analyse the determinants of rural households’ WTP for safe water. A survey of 120 households was conducted and a Tobit model was employed to determine the factors affecting households’ WTP for improved water quality and quantity. The study found that the age of a household head had a negative and statistically significant influence on WTP. This meant that as the older the household head, the less the household will be willing to pay for both quality and quantity. Waiting time and education level were found to be positively associated with a higher WTP. The study also reported that water consumption, household income and water source were significantly related WTP for better water quantity but with a negative sign. This basically meant that the more water a household consume, the more income the household generate and the more alternative water sources a household have, the less the household will be willing to pay for more quantities of water.
A study conducted in Botswana, by Moffat et al. (2011) estimated WTP for improved water quality and reliability. The study employed a multiple linear regression model which included only real monetary values as the dependent variable. The researchers found that on average 54 percent of the households in the study area were willing to pay for improved water quality at an estimated mean WTP of P76.78 (Pula). From the regression analysis, the study found that income was positively and significantly related to WTP for water quality and reliability. This result was also true with other researchers (Akter, 2007; Choe et al., 1996; Kolstad, 2002), who corroborate with environmental economic theory which assumes that demand for an improved environmental amenity increases with income. The study also found that age was also positively and significantly related to WTP. This means that the older the household head the more willing to pay. The variables household size and education were negatively and significantly related to WTP.

In a recent study, Kanayo et al. (2013) used the CVM to identify the determinants of households WTP for improved water supply in Nsukka, Nigeria. The study mainly wanted to elicit the monetary value which the communities were willing to support government for such projects. The study surveyed 220 households and used a censored (tobit) model to determine the socio-economic factors affecting WTP. The results showed that the WTP for water was sensitive to the level of education, occupation of the household head, prices charged by water vendors, expenditure on water vending and the average monthly income of the households.

In Nebelet, Ethiopia, Mezgebo and Ewnetu (2015) used the CVM to analyse households WTP for improved water services. Data used in the study were surveyed
from 181 households and a probit model was used to identify socio-economic factors affecting WTP. Results from the model showed that household income, distance to water source, water expense, education of household head, level of existing water satisfaction, the bid value, gender of household head and marital status were all associated with households WTP for improved water services. The results from the study were in-line with economic theory as both income and the bid values had positive and negative signs, respectively.

2.5 Empirical literature on water demand in developing countries

Mu et al. (1990) estimated water demand behaviours in Ukunda rural Kenya using a sample size of 69 households. The sources of water for the population included kiosks, water vendors, hand pumps and open wells. The study used the multiple linear regression model (OLS method) and the household water per capita per day as the explained variable. The results showed that collection time was significant but with a negative sign meaning that the more time spent on water collection, the less water consumed per day. Income was positively and statistically significant to water consumption. This meant that consumption of water increases with income.

In four cities of Saudi Arabia, Rizaiza (1991) studied household water usage using a sample size of 563 households. Water sources for households in the study were private water connection and tankers. The study thus used separate demand equations (OLS methods) for households with private connections and those supplied with tankers. The dependent variable was annual water demanded per household. Results from the study showed that family size, average temperature and ownership of a private garden were statistically significant with a positive sign from both sources.
This meant that increase in the family size increases demand for water. Similarly, increase in temperatures and ownership of a garden raises household annual water demand. The study further reported that price elasticity of demand was ranging from -0.40 for tankers to -0.78 for private connection.

A recent study by Coster and Otufale (2014) in Nigeria, Ogun State estimated both household water use and willingness to pay for improved water services. Major sources of water for households included private connection, public piped, wells and rivers. Using data from 216 randomly selected households, the study employed the Generalized Linear Model (GLM) and binary logit regression analysis to estimate household water demand and determinants of WTP, respectively. Results from the demand model showed that connection charges, household size, marital status and availability and quality of water were positive and statistically significant to water use. Distance to water source and unit price for piped water also proved to be statistically significant to water use but with a negative sign. This meant that the longer the distance to water source, the less water used by a household.

Nauges and van den Berg (2006) studied households’ water safety perceptions and sanitation practices in Sri Lanka. The researchers used a sample size of 1800 households whose main water sources were private water connection, wells, public taps, neighbours and surface water. The study used the Two-step Heckman method to control for private water households and the Tobit model for non-piped households. The depended variable used was water consumption per capita per month or per day for households with private water and non-private water, respectively. Results from the study showed that the price elasticity of piped households ranged from -0.15 to -
0.37 while income elasticity was estimated to be at 0.14. Time in hours of water availability was also significant and a positively influencing water consumption for piped households.

For households with no private connection, the study reported that income elasticity was estimated to be at 0.20. This meant that an increase in unit income for households without private water connection increases the amount spent on water by 20%, *ceteris paribus*. Collection time and household size were statistically significant but with a negative sign for households without private water connection. This suggested that the more time spent on collection the less water consumed by a household. Similarly, this meant that the more the number of people living in a household, the lower water consumed per day which is a strange result. The use of a storage water tank was also positively and statistically significant to both households with private water consumption and those without.

In Salatiga Indonesia, Rietveld et al. (2000) estimated the demand function for block rate pricing of water. The study used a sample of 951 households and their water sources were from private water connection, neighbours with connection, community water terminal, wells and rivers. The study used a single demand equation for households with private water connection, specifically the discrete-continuous approach by Burtless and Hausman (1978). Using household water use per month as the dependent variable, the study found price and income elasticities of water demand to be at -1.2 and 0.05, respectively. Household size was statistically significant with a positive sign, indicating that an increase in household size results in increases in water
used. The uses of extra sources of water also showed to be statistically significant but with a negative sign.

### 2.6 Concluding Summary

The purpose of this Chapter was to provide a theoretical and empirical review of literature pertaining the non-market economic valuation of water services and water demand. From the reviewed literature, it is clear that community water services possess the characteristics of public goods, hence have missing markets. With a missing market, the market price is regarded as unreliable; this brings about the need to obtain economic values to at least approximate socially acceptable water tariffs or benefits. Furthermore, the review of literature showed that besides the number of biases, the CVM is one economic tool which can be used to directly elicit the economic value that individuals place on environmental or public goods, this case being improved water services. The theoretical and empirical literature reviewed also guided the hypotheses and methods used in the study. Different econometric methods and determinants of WTP for water services and water demand were reviewed which further guided the study.
3.1 Conceptual Framework

The study uses the CVM, which is a non-market valuation approach to estimate the economic value of rural water services. With the current property rights and institutions, water in the rural areas is a non-market good, so non market valuation approach is appropriate to estimate WTP. The theoretical foundation of economic values for environmental and public goods like community water, are defined in the perspective of their effects on human welfare (Krieger 2001; Agudelo, 2001). A change in environmental goods (community water) can affect individual’s welfare through changes in prices they pay for other private goods in the market, and changes in the quantities or qualities of other non-marketed environmental goods like domestic water.

It is, however, worth mentioning that contingency valuation surveys can utilize four equivalent welfare measures and these are EV, CV, CSU and ESU which are discussed in Section 2.2. Both EV and CV can be used when we are dealing with price changes, while CSU and ESU can be used when dealing with changes in environmental quality or quantity (Markandya et al., 2002). The conceptual framework adopted in the study is as shown in Figure 1. As it can be shown, with the improved water project, the proper measure to assess the economic benefits depends firstly on the nature of the change we are valuing (price / quality / quantity change). The measure will also depend on the direction of the change and the concept of
elicitation used (WTP or WTA). Accordingly, the decision on WTP or WTA from the household is affected by households’ characteristics, perceptions and preferences.

![Conceptual Framework for Improved Water Services](image)

**Figure 3.1** Conceptual Framework for Improved Water Services

Source: Adopted from Markandya et al. (2002) with modifications.

Where: CV = Compensating Variation, EV = Equivalent Variation, CSU = Compensating Surplus and ESU = Equivalent Surplus

The ‘linkage’ adopted in this study is marked by black arrows and grey boxes. We measure the change in welfare as a result of the improved water services using WTP instead of WTA. According to Garrod and Willis (1999), asking WTP or WTA depends on property rights. If the respondents do not own the right to the good, in our
case being improved water services, then WTP should be asked. Conversely if the respondents own the right to the good, then WTA is the relevant measure. Carson (1991) suggests that WTP should be used whenever the individual might incur benefits from the proposed policy. It is thus the study uses CSU to estimate maximum WTP for an improvement in community water services.

3.2 Theoretical Framework

The theoretical basis for the contingency valuation approach relies upon micro-economic theory of welfare change. Households maximize their utility subject to an income constraint, or minimize their expenditure subject to a given utility constraint (Hanley and Spash, 1993). When evaluating the environmental improvement, in order to be able to derive the corresponding demand function for both the environmental good \( w \) and market goods \( x \), we have to imagine a market situation where the individual actually is able to choose the level of \( w \) and \( x \) given their prices denoted by \( p_w \) and \( p_x \), respectively (Hanemann, 1999).

\[
\text{Max}_x U = U(x, w) \quad \text{s.t} \quad M = p_x x + p_w w
\]  

(1)

Where \( U(.) \) is the utility function, \( x \) is the composite of all market goods and \( w \) is the public good quantity. \( p_x \) and \( p_w \) are the prices of both market goods and the public good (water), respectively, and \( M \) is household income. Solving the maximization problem we use the Lagrange’s Multiplier and is specified as follows.

\[
\mathcal{L} = U(x, w) + \lambda(M - p_x x - p_w w) = 0
\]  

(2)
Where $\lambda$ is the Lagrange multiplier. The first order conditions of the langrange can be computed as follows.

\[
\frac{\partial L}{\partial x} = \frac{\partial u(x,w)}{\partial x} - \lambda p_x = 0
\]

(3)

\[
\frac{\partial L}{\partial w} = \frac{\partial u(x,w)}{\partial w} - \lambda p_w = 0
\]

(4)

\[
\frac{\partial L}{\partial \lambda} = M - p_x x - p_w w = 0
\]

(5)

The last condition is simply the constraint. We can rearrange the first two equations and divide the first equation by the second equation to get the technical rate of substitution which must equal the price ratio (Varian, 2010).

\[
\frac{\frac{\partial L}{\partial x}}{\frac{\partial L}{\partial w}} = \frac{\frac{\partial u(x,w)}{\partial x}}{\frac{\partial u(x,w)}{\partial w}} = \frac{p_x}{p_w}
\]

(6)

Solving further the utility maximization problem, we get the Marshallian demand functions for both market goods and water which are a function of income and the prices for both private goods and water.

\[
x^m = d^x(p_x, p_w, M)
\]

(7)

And

\[
w^m = d^w(p_x, p_w, M)
\]

(8)

Substituting the demand function into the given utility function one derives the indirect utility function which forms the underlying basis of welfare change estimation. With the demand functions (5) and (6) derived from the utility
maximization process, we can form the indirect utility function \( V(p_x, p_w, M) \) that corresponds to the utility function \( U(x, w) \) as follows:

\[
V(p_x, p_w, M) = U(d^x(p_x, p_w, M), d^w(p_x, p_w, M))
\] (9)

Therefore, the indirect utility function expresses the maximum utility that can be achieved given prices of both water and market goods, and income. The indirect utility function and the expenditure function provide the theoretical structure for welfare estimation (Haab and McConell, 2002)\(^2\).

In this study, improved water services is represented by a scenario whereby the household will receive continuous water from a proximate water source, and the water will be of good quality without the need for boiling or any other treatment, however provided at a minimum price of water. Therefore, for this reason, we assume that through the water project, a measurable indicator of quality or quantity \( q \) will change from the current status quo \( (q_o) \) to a new status \( (q_1) \), where \( q_o < q_1 \). Consequently, the household’s utility functions with the quality or quantity indicator changes from \( U_0 \equiv v(p_x, p_w, M, q_o) \) to \( U_1 \equiv v(p_x, p_w, M, q_1) \). Therefore, in order to measure in monetary terms, the change in utility, we use the Hicksian measure of CSU and is as shown below

\[
V(p_x, p_w, M, q_o) = V(p_x, p_w, M - CSU, q_1)
\] (10)

\(^2\) One can also consider the dual minimization problem in which expenditures on \( x \) and \( w \) are minimized subject to a given utility level.
As the change from $q_o$ to $q_1$ is a result of the improvement in water services which raises the utility level of a household, to make the household indifferent between the two utility levels, CSU must be positive. In this case, CSU measures the households WTP:

$$V(p_x, p_w, M, q_o) = V(p_x, p_w, M - WTP, q_1) \quad (11)$$

WTP is the maximum amount of money the household will pay in exchange for the improvement in the water services.

### 3.3 Empirical Framework

The study used both descriptive and statistical analyses in addressing the study objectives and research questions.

#### 3.3.1 Estimating mean willingness to pay

As already mentioned, the study uses the dichotomous choice with a follow up question to estimate WTP for an improvement in water services in the study area. The mean is an appropriate welfare measure but not the median (Hanemann and Kanninen, 1999). For the same reason, the study employs the bivariate probit for double bounded models in estimating mean WTP for improved water services. This is mainly because the bivariate normal density function is appealing in the sense that it allows for non-zero correlation, while the logistic distribution does not. In addition, constraining the parameters in the bivariate probit model yields other models such as the interval data model and the random effects probit model (Cameron and Quiggin,
The econometric model used in a double bounded question starts from equation (12) which simply characterizes a household’s unobserved true willingness to pay.

\[ WTP_{ij}^* = \mu_i + \varepsilon_{ij} \]  

(12)

Where; \( WTP_{ij} \) denotes households’ \( j^{th} \) WTP for improved water services that is unobservable and \( i=1, 2 \) represents the respondents’ response to the first and second questions (bids). \( \mu_1 \) and \( \mu_2 \) are basically the means of the first and second bid responses. Proposing that \( \mu_{ij} = X'_{ij} \beta \) permits both the means to be reliant upon the characteristics of the respondents.

We assume that mean WTP is the same for all individuals, but potentially varies across question. To construct the likelihood function, we first derive the probability of observing each of the possible two bid response orders [Yes-Yes, Yes-No, No-Yes and No-No]. The probability that household \( j \) answers yes to the initial bid, \( Y_1 \), and yes again to the follow up bid, \( Y_2 \), is given by;

\[ \Pr(\text{yes, yes}) = \Pr(WTP_{1j} > Y_1, WTP_{2j} \geq Y_2) \]

\[ = \Pr(\mu_1 + \varepsilon_{1j} > Y_1, \mu_2 + \varepsilon_{2j} \geq Y_2\mu) \]  

(13)

The probability that respondent \( j \) answers yes to the initial bid question and no to the second is given by;

\[ \Pr(\text{yes, no}) = \Pr(WTP_{1j} \geq Y_1, WTP_{2j} < Y_2) \]

\[ = \Pr(\mu_1 + \varepsilon_{1j} \geq Y_1, \mu_2 + \varepsilon_{2j} < Y_2\mu) \]  

(14)
The other two response sequences of no-yes and no-no can be constructed analogously. Therefore, following Haab and McConnell (2002), households’ $j^{th}$ contribution to the likelihood function is given as:

$$L_j(\mu_j|Y) = \Pr(\mu_1 + \epsilon_{1j} > Y_1, \mu_2 + \epsilon_{2j} < Y_2)^{Y_N} \ast \Pr(\mu_1 + \epsilon_{1j} > Y_1, \mu_2 + \epsilon_{2j} > Y_2)^{Y_Y} \ast \Pr(\mu_1 + \epsilon_{1j} < Y_1, \mu_2 + \epsilon_{2j} < Y_2)^{N_N} \ast \Pr(\mu_1 + \epsilon_{1j} < Y_1, \mu_2 + \epsilon_{2j} > Y_2)^{N_Y} \quad (15)$$

Where; $Y_Y = 1$ for a yes-yes answer, 0 otherwise, $Y_N = 1$ for a no-yes answer, 0 otherwise, $Y_N=1$ for a yes-no answer and $N_N=1$ for a no-no answer, 0 otherwise. This formulation is referred to as the bivariate discrete choice model. Assuming errors are normally distributed with means 0 and respective variances of $\sigma_1^2$ and $\sigma_2^2$ and correlation coefficient $\rho$, then $WTP_{1j}$ and $WTP_{2j}$ have a bivariate normal distribution with means $\mu_1$ and $\mu_2$, and variances $\sigma_1$ and $\sigma_2$, and correlation coefficient $\rho$. Given the dichotomous choice responses to each question, the normally distributed model is referred to as the bivariate probit model. Deriving the likelihood function for the bivariate probit model, we use the probability of all four possible response sequences.

The probability of a yes-yes response is given as:

$$\Pr(\mu_1 + \epsilon_{1j} > Y_1, \mu_2 + \epsilon_{2j} \geq Y_2) = \Phi_{\epsilon_1, \epsilon_2}(-\frac{y_1-\mu_1}{\sigma_1}, -\frac{y_2-\mu_2}{\sigma_2}, \rho) \quad (16)$$

Where; $\Phi_{\epsilon_1, \epsilon_2}(.)$ is the standardized bivariate normal cumulative distribution function with zero means, unit variances and correlation coefficient $\rho$. The probability of a yes-no response is given as:

$$\Pr(\mu_1 + \epsilon_{1j} \geq Y_1, \mu_2 + \epsilon_{2j} < Y_2) = \Phi_{\epsilon_1, \epsilon_2}(-\frac{y_1-\mu_1}{\sigma_1}, \frac{y_2-\mu_2}{\sigma_2}, \rho) \quad (17)$$

The other two probabilities of response sequences can be constructed analogously. Letting $y_{1j}=1$ if the response to the first question is yes and 0 otherwise, $y_{2j}=1$ if the
response to the second question is yes and 0 otherwise the resulting likelihood function for a bivariate probit is given below as;

\[ L_j(\mu|Y) = \Phi_{\varepsilon_1\varepsilon_2}(d_{1j} \left( \frac{y_{1j} - \mu_1}{\sigma_1} \right), d_{2j} \left( \frac{y_{2j} - \mu_2}{\sigma_2} \right), d_{1j}d_{2j}\rho) \]  

(18)

Where;

\[ \Phi_{\varepsilon_1\varepsilon_2}(\cdot) = \text{standardized bivariate normal cumulative distribution function} \]

\[ d_{1j} = y_{1j} - 1 \] and \[ d_{2j} = y_{2j} - 1 \]

\[ \sigma_1 \text{ and } \sigma_2 = \text{standard deviation of errors} \]

\[ \rho = \text{correlation coefficient} \]

Finally the mean WTP from bivariate probit model will be computed using the formula specified by Haab and Mconnell (2002) that is,

\[ \text{mean WTP} = -\frac{\alpha}{\beta} \]  

(19)

Where; \( \alpha \) is a coefficient for the constant term, and \( \beta \) is a coefficient for offered bids to respondents.

### 3.3.2 Factors affecting willingness to pay

The study attempts to quantify the relationship between household characteristics and the probability that a household will be willing to pay the initial randomly offered bid value. Given the initial specified amount that have to be subtracted from a given households’ income for the proposed improved water services, households have the choice to either accept or decline the pre-specified bid value. Understanding how this
decision (WTP) is associated with individual characteristics enhances researchers to gain more information on the validity and reliability of the CVM and to further generalize sample results with the general population (Haab and McConnell, 2002). It is therefore important to explore individual household characteristics affecting this WTP for the dichotomous choice question in the CVM survey.

According to Hanemann (1984), the decision of a household to either accept or decline the randomly pre-specified bid can be modeled in a simple utility framework as shown below;

\[ u_{ij} = u_i(m_j, x_j, \varepsilon_{ij}) \]  \hspace{1cm} (20)

Where \(i = 0\) for the current status quo and \(i = 1\) is the state that prevails when the water project is implemented, the final state. The utility function is a function of \(m_j\), household’s \(j^{th}\) income, \(x_j\), vector of household characteristics and choice attributes, and \(\varepsilon_j\), a component of preferences known by the individual respondent but unobserved by the researcher. The basic assumption in this study is that through this water project, a measurable attribute is changed. This can be a quality indicator \(q\), changing from \(q^0\) to \(q^1\). Introducing the quality indicator into the utility framework, the current status quo becomes \(u_{0j} = u(m_j, x_j, q^0\varepsilon_{0j})\) and final state becomes \(u_{1j} = u(m_j, x_j, q^1\varepsilon_{1j})\).

As household income is the principal limiting factor for the household, it thus assumed that a household \(j^{th}\) will be willing to pay the initial pre-specified bid \(y_l\) given the utility with the proposed project exceeds the current status quo or otherwise reject the bid;
The probability that a respondent will accept the initial bid is basically the probability that the respondent thinks he is better off with the proposed water project than without it, even given the required payment from him so that $u_1 > u_0$. The probability function for household $j$ becomes:

$$
Pr(\text{yes}_j) = \left( u_1(m_j - y_j, x_j, \varepsilon_{ij}) > u_0(m_j, x_j, \varepsilon_{0j}) \right)
$$

Given the probability statement above, for parametric estimation, two modelling decisions need to be taken. Firstly, the functional form of the utility function $u(m_j, x_j, \varepsilon_{ij})$ must be chosen. Secondly, an assumption about the distribution of the error term, $\varepsilon_{ij}$, must be made. For the same reason, the utility function can be specified as additively separable as shown below:

$$
u_i(m_j, x_j, \varepsilon_{ij}) = v_i(m_j, x_j) + \varepsilon_{ij}$$

Where $V_i(.)$ is the indirect utility. The probability function equation (22), with the additive specification for the $j$th household is thus as shown below.

$$
Pr(\text{yes}_j) = Pr[v_i(m_j - y_j, x_j) + \varepsilon_{ij} > v_0(m_j, x_j) + \varepsilon_{0j}] 
$$

It is, however, worth mentioning that the utility functions are usually unobservable. Given that the deterministic part of the utility function is linear in household income and individual characteristics, the linear utility function can be specified as follows;

$$
v_{ij}(w_j) = \alpha_i x_j + \beta_i(m_j)
$$

Where $w_j$ is household $j$th income, $x_j$ is the m-dimensional vector of household characteristics and $\alpha_i$ is the vector of parameters. The CV scenario induces the
respondent to choose between the current water conditions and the proposed conditions of the final state with the required payment $y$. The linear utility function with the CV scenario becomes:

$$v_{1j}(m_j - y_j) = \alpha_1 x_j + \beta_1 (m_j - y_j) \quad (26)$$

Where $y_j =$ initial bid presented to the respondent. The utility function of the status quo becomes

$$v_{0j}(w_j) = \alpha_0 x_j + \beta_0 m_j \quad (27)$$

Therefore, the change in utility given by the proposed implementation of the water project can be given by

$$v_{1j} - v_{0j} = (\alpha_1 - \alpha_0)x_j + \beta_1(m_j - y_j) - \beta_0 m_j \quad (28)$$

The main intuitive of WTP in this scenario is to remove a specified amount $y$ from a household income so as to leave a household indifferent between the two scenarios. Thus it is justifiable to assume that income is constant between the two states unless the project provides substantial change. With income constant between the states, $\beta_1 = \beta_0$, and the utility difference becomes;

$$v_{1j} - v_{0j} = \alpha x_j - \beta y_j \quad (29)$$

With the deterministic part of preferences specified, the probability of responding yes becomes

$$Pr(\text{yes}_j) = Pr(\alpha x_j - \beta y_j + \epsilon_j > 0) \quad (30)$$

Where $\epsilon_j \equiv \epsilon_{1j} - \epsilon_{0j}$ as the differences between the random terms in the current status and final state cannot be recognized. Assuming that the error terms $\epsilon_1$ and $\epsilon_0$ are
independently and identically distributed (IID) with zero means gives two commonly used distributions. The probability that the respondent will accept the dichotomous choice question can be estimated as follows;

$$
\Pr(\alpha x_j - \beta y_j + \varepsilon_j > 0) = \Pr(- (\alpha x_j - \beta y_j) < \varepsilon_j)
$$

$$
= 1 - \Pr(- (\alpha x_j - \beta y_j) > \varepsilon_j)
$$

$$
= \Pr(\varepsilon_j < \alpha x_j - \beta y_j)
$$

The last inequality represents the symmetric distribution $F(x) = 1 - F(-x)$. This form representation gives us the underlying structural model for estimating the probability of accepting the specified initial bid. The two widely used distributions are the normal and logistic distributions, and are estimated using the probit and logit model, respectively, depending on the assumption on the distribution of the error term ($\varepsilon$) and computational convenience (Greene, 2002). Assuming a normal distribution of the error terms the probit model can be specified. The probit model can thus be specified as latent variable by a structural equation as (Greene, 2002).

$$
Y_i^* = X' \beta + \varepsilon_i
$$

$$
Y_i = \begin{cases} 
1 & \text{if } Y_i^* \geq y_1 \\
0 & \text{if } Y_i^* < y_1 
\end{cases}
$$

Where;

$Y_i^*$ = the unobserved but true WTP for improved water services.

$\beta$ = is the vector of parameters

$X'$ = is the vector of characteristics or explanatory variables

$Y_i$ = Discrete response of the respondents for the WTP
\[ Y_i = \text{the offered initial bids assigned randomly to the } i^{th} \text{ respondent} \]

\[ \varepsilon_i = \text{Unobserved random component distributed as } N(0, \sigma^2) \]

### 3.3.3 Factors affecting household water consumption

The last objective of the study was to identify factors affecting daily household water used per capita in the study areas. Theory suggests that water demand can be well-defined as a function of own price, price of other related goods, income and other socio-economic variables. As the price of water is not common in the rural areas, the demand function for water follows the following formulation.

\[
D_w = f(I, N, Z) \tag{33}
\]

Where \(D_w\) represents the demand for water as a function of household income (\(I\)), household size (\(N\)) and other socio-economic variables (\(Z\)).

The linear functional form for household water use per capita used in the study is the double-log model adopted from the standard multiple regression model. This form of analysis is chosen because of its desirability in estimating coefficients of the linear equation involving multiple independent variables, which best predict the value of the dependent variable (Greene, 2002). From the double-log model, the estimated coefficients from continuous variables are elasticities and the error term is contemporaneously independent (Strand and Walker, 2005). The dependent variable was the log of daily per capita water consumed. Households were asked to estimate their water consumption quantities per day in litres and that quantity was divided by the number of family members staying in the household. The log-linear regression model is specified as follows;
\[ \ln Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + \beta_9 \ln X_{9i} + \beta_{10} \ln X_{10i} + \varepsilon_i \]  

(34)

Where \( \log Y_i = \log \) of daily water consumption per capita in litres

\( \beta_0 = \) intercept coefficient

\( \beta_1, \beta_2, \ldots, \beta_{10} = \) coefficients of the explanatory variables

\( X_{1i} = \) Marital status of household head

\( X_{2i} = \) Gender of household head

\( X_{3i} = \) Ownership of a water tank

\( \ln X_{4i} = \) Log of number of trips to collect water per day

\( \ln X_{5i} = \) Log of education of household head measured in years of schooling

\( \ln X_{6i} = \) Log of household head’s age

\( \ln X_{7i} = \) Log of average household income per month measure in Emalangeni (E)

\( \ln X_{8i} = \) Log of distance travelled to collect water measured in metres (m)

\( \ln X_{9i} = \) Log of household size

\( \ln X_{10i} = \) Log of years using current water source.

\( \varepsilon_i = \) error term with an assumption of \( N(0, \beta^2) \) and \( i = 1, 2, \ldots n \)

In the model, the meaning of \( \beta_1 \) is basically the effect of a percentage increase in \( X_1 \) on \( Y \), the per capita water consumed, holding all other independent variables constant.
3.4 Description of variables and expected outcomes

3.4.1 Dependent Variables

3.4.1.1 Willingness to pay for water

The dependent variable for bivariate probit analysis is dichotomous in nature and measures WTP for improved community water services using two binary variables each taking a value of 1 if the household is willing and 0, otherwise. The first binary relies on the answer to the first bid offered and second one relies on the answer to the follow up question (bid). This is the key dependent variable in answering the objective on mean WTP for improved water services.

3.4.1.2 Willingness to pay initial bid

The second dependent variable used in the study was willingness to pay, using the response to the initial randomly offered, for improved water services. The variable is also binary, taking the value 1 if the household was willing to accept the initial bid offered and 0, otherwise. This variable is used as a dependent variable in answering the objective on determinants of willingness to pay for improved water services in the study areas.

3.4.1.2 Water Consumption

The last dependent variable used in the study was average daily per capita water consumed in litres. This is a continuous variable taking only 0 or positive values. As rural households do not use water meters, information on water consumption was estimated by households on their average daily water consumption. This was divided
by the number of members per household. Many rural households used sized buckets (of 20 litre and 25 litres) when collecting water, thus making estimations less cumbersome.

3.4.2 Independent Variables

3.4.2.1 Age of household head (Age): This variable is measured as a continuous variable and was expected to affect the decision taken by households on WTP for improved water services negatively. This is mainly because old people in most rural areas are generally poor and have no viable income source. Therefore, it was expected that the older the household head, the less likely for him/her to pay. Ogunniyi et al. (2011) found the same result that age of the household head was negatively and statistically significant to WTP for safe and clean water. Furthermore, it was not possible to hypothesize how the age of the household head will affect water consumed per capita. However, it was expected that as people grow older, they will use less water than younger ones thus a negative sign was expected.

3.4.2.2 Sex of household head (Gender): This variable was measured as a dummy variable taking the value of 0 for female headed households and 1 for male headed households. The variable was expected to negatively affect WTP decision as in most rural households it is the women who bear the burden of collecting water thus would be more willing to pay than males (Moffat et al. 2007). Farolfi et al. (2007) found a similar result in that women are more willing to pay for improved water quality and quantity than males. On the other hand, the variable was also expected to exhibit a negative association with daily per capita water consumed. This is because it is
women who do most daily household chores which require water like, cleaning, washing, cooking, etc.

3.4.2.3 **Average household income (HHIncome):** This variable was measured in Emalangeni (E) and is the average amount of income the household generates from various sources. Economic theory postulates that demand for improved goods increases with increases in income. Thus following the theory, the study hypothesized that income to be positively associated with both WTP for improved water services and per capita demand for water. This is mainly because households with higher incomes will demand more improved goods like water services than households with lower incomes, thus be demanding and willing to pay more. This hypothesis is similar to the findings of Khan et al. (2010), Farolfi et al. (2007), Ogunniyi et al. (2011) and Kanayo et al. (2013).

3.4.2.4 **Quality of water used (WaterQuality):** Rural households derive water from various sources including rivers, wells, community boreholes etc. Thus the quality of water as perceived by respondents took the form of a categorical variable taking values 1- 5 (1= very poor, 2=poor, 3=just ok, 4=good and 5=very good). It was expected that households who perceive their current water used as poor to be more willing to pay than households satisfied with water quality. Thus, a negative sign was expected.

3.4.2.5 **Distance to water source (Distance):** Measured as a continuous variable in metres (m), the distance to water source was expected to positively affect the WTP decision while negatively affecting water consumption. This was because households
who have the burden of travelling long distances to collect water would be willing to vote for an improvement than those living nearby. The hypothesis is similar with the findings of Farolfi et al. (2007), Banda et al. (2006) and Alaba (2001). Water consumption was expected to be negatively associated with distance because longer distances reduce water collection frequency. It is thus expected that a longer distance to water source reduces water consumption.

3.4.2.6 Education level of household head (EduLevel): This is a continuous variable indicating the number of years that the household head had spent in a formal school. Higher education levels were hypothesized to have a positive effect on both WTP decision and water consumption. It is assumed that formal schooling enhances households’ knowledge about sanitary measures. Therefore, households’ heads with more education were expected to know about the importance of clean (improved) water and thus be willing to pay for an improvement of such a service. Kanayo et al. (2013) and Ogunniyi et al. (2011) also found a similar result. Similarly, consumption levels of water will be higher for educated headed households as they know about the importance of sanitation and thus will demand more.

3.4.2.7 Household size (HHsize): This is measured as a continuous variable indicating the number of individuals living in the household. It was hypothesised that household size will positively affect both WTP and household water consumption. This is because larger family sizes may demand more water and thus for the same reason be willing to pay for such service. Likewise, large households demand more water because daily discretionary water use for basic needs such as drinking, washing
clothes and dishes, baths etc., will increase and thus raises their daily water consumption.

3.4.2.8 Number of trips taken to collect water (No.oftrips): This is a continuous variable measuring the average number of trips taken by household members to collect water per day. It was expected that households who travel to collect water more frequently will have higher per capita water consumption than their counterparts; hence a positive sign was expected.

3.4.2.9 Ownership of a water tank (WaterTank): A household may buy a storage tank in order to mitigate problems with reliability from water source. Households can use the water tank to harvest rain water or buy water from water vendors (water tankers) which can enhance reliability problems. It is, therefore, expected that households owning a water tank will have higher per capita water consumption than their counterfactuals not owning one. A similar result was found by Cheesman et al. (2008) and Nauges and van den Berg (2009).

3.4.2.10 Social status of household head (S. Position): This is a dummy variable taking the value 1 if the household head holds a social position in the community and 0 otherwise. Being in social positions inspires some form of social responsibility and it was thus expected that being in one will influence willingness to pay positively given the community development (water) project.

3.4.2.11 Household daily water used (HHwaterused): This is a continuous variable measuring the average amount of water used in the household per day in litres. It was
expected that the variable exhibit a negative association with WTP. This was mainly because households using large quantities of water may be satisfied thus not be willing to pay for an improvement of such a service.

3.4.2.12 Averting behaviours (AvertingBehaviour): Before water is consumed, households can practice preventative measures to assure good health. Such can include boiling, refrigerating, use of chemicals and others. Therefore, this variable was measured as a dummy taking the value of 1 if a household practice any averting behaviours before using water and 0 if otherwise. The variable was expected to positively influence WTP as it is households who are aware about the importance of using clean water who practice averting behaviours and thus are expected to be willing to pay.

3.4.2.13 Household garden (HHgarden): This is another dummy variable which takes the value of 1 if a household owns a small back yard garden and/or 0 otherwise. The variable was expected to show positive association with WTP as households with a garden may be willing to pay more for a more closer and reliable source.

3.4.2.14 Lower Bid value (LowerBid1w): This is a continuous variable measured in Emalangeni (E), representing the initial randomly specified bid value. The variable was expected to affect WTP negatively which is in line with economic theory of demand.

3.4.2.15 Upper Bid value (UpperBid1w): Another continuous variable measured in (E) representing the follow-up bid value presented to respondents. This variable was
used on the estimation of mean WTP. Similarly, a negative sign was expected from the variable guided by economic theory.

3.5 Study Area

Swazililand has four climatic regions, namely, Hhohho, Manzini, Shiselweni and Lubombo. These regions consist of 55 constituencies (Tinkhundla) and within each constituency there are about 5 - 10 chiefdoms (CSO, 2007). The study was mainly based in the semi-urban areas of Shiselweni and Lubombo regions, specifically in Siphofaneni, Somnotongo and Matsanjeni. These areas were chosen due to a current water project which aims at improving water and sanitation services in the areas. The project supports the expansion of an existing network of treated potable water to include an additional 46000 people which is about 7980 households (CSO, 2007). These areas are considered to be in the poorest regions in the country and receive the least rainfalls. Thus, being water stressed areas, community water projects are the main viable source of water for households.

3.6 Sampling Technique and Sample Size

This study mainly used primary data which were collected through a contingent valuation survey using personal interviews. A purposive method of sampling was adopted by selecting the study areas mentioned above. Although disadvantageous, non-probability sampling methods like purposive sampling, in terms of statistical precision are generally recognized (Churchill, 1995). This was an appropriate method considering the limitations of the study. Time and money limited the study from including other areas or regions for more investigation. Hence, the study used
purposive sampling, which is most desirable when certain important segments of the target population are intentionally included in the study.

To calculate the sample size, \( n \), given the population size \( N \) and the estimated population proportion in the selected study site, the study employed the sample size determination as follows (Kothari, 2009):

\[
n = \frac{z^2}{e^2 \left( \frac{N-1}{N} \right)} \cdot \frac{p \cdot q \cdot N}{z^2 \cdot p \cdot q}
\]

(35)

Where: \( n = \) sample size, \( z = \) the \( z \)-value of the desired degree of confidence, \( p = \) the population proportion of households of interest, \( q = 1 - p \), and \( e = \) the absolute size of error and \( N \) is the population size.

\[
n = \frac{1.65^2}{0.05^2 \left( \frac{7980-1}{7980} \right)} \cdot \frac{(0.5)(0.5)7980}{1.65^2(0.5)(0.5)} = 273
\]

Where \( N = 7980 \), \( p = 0.5 \) (assumed to be 0.5 as this gives the maximum sample size), \( q = 0.5 \), \( z = 1.65 \) at \( \alpha = 0.1 \) and \( e = 0.05 \). An additional 15 percent of the calculated population size was made to cater for non-response and spoilt questionnaires. Thus, a total sample size of 314 households were randomly sampled and surveyed in the study areas. Using population proportion to size in the three study areas the number of households collected per constituency and chiefdom are as shown in Table 3.1.

Succeeding the purposive method was a two-stage cluster sampling method where chiefdoms in the study areas were used as strata. In each strata, simple random sampling method was employed where households were selected with population proportion to size sampling technique to acquire the desired sample size. This method
was chosen because of its merit in ensuring a high degree of representativeness by providing the respondents with equal chances of being selected as part of the sample.

**Table 3.1 Summary of Sampled Households**

<table>
<thead>
<tr>
<th>Constituency</th>
<th>Total No. of HH</th>
<th>Sample %</th>
<th>Chiefdom</th>
<th>Sample</th>
</tr>
</thead>
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<tr>
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<td>32.2</td>
<td>Kuphumuleni</td>
<td>35</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Babitje</td>
<td>36</td>
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<td>Qomintaba</td>
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<td>13.7</td>
<td>Luhlekweni</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vimbizibuko</td>
<td>27</td>
</tr>
<tr>
<td>Siphofaneni</td>
<td>4442</td>
<td>54.1</td>
<td>Kamkhweli</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Madlenya</td>
<td>98</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7980</strong></td>
<td><strong>100</strong></td>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Central Statistics Office (CSO) and own calculations.

**3.7 Data and Collection Methods**

The study used both primary and secondary sources of data to gather information for the study. Primary data were collected from sampled households through interviews using structured questionnaires as recommended by Arrow et al. (1993). Furthermore, Carson (2000) stresses that personal interviews are better compared to mail surveys because they don’t exclude people who may have reading difficulties and that they make the hypothetical scenario more understandable as the use of photographs, maps, drawings and many more can be adopted and presented to respondents.
Primary data collected included detailed information on households WTP, household characteristics, water consumption, expenditure on water and other data related to various dimensions of household water use. Five enumerators from the University of Swaziland were hired to conduct face to face interviews. Prior to data collection, enumerators were thoroughly trained on undertaking a CV survey by the principal researcher. Secondary data collected included published and unpublished sources such as reports from the Central Statistics Office (CSO), Swaziland Water Services Cooperation (SWSC), Department of Water Affairs (DWA) and relevant Journal articles.

The CVM was used to elicit WTP for improved community water services. This method is chosen mainly because of its suitability in measuring use and non-use value as compared to other non-market valuation methods like the travel cost method (TCM) which undermines the importance of non-use values of an environmental or public good, in this case being improved community water services. This is very important as it provides non users’ a preservation fee, that is, households with private water supply can still contribute on providing community water.

As already discussed, there are about four main elicitation formats used in any CV survey and these are; Bidding game, Payment card, Open ended and Dichotomous choice method. The study used the dichotomous choice method with a follow up question where households were asked a sequence of questions which led to WTP. This method was originally developed by Hanemann et al. (1991) and mainly involves questioning respondents two yes or no WTP questions where the bid price in the second or follow-up question is higher (lower) if the answer to first question is
positive (negative). The dichotomous choice method with a follow up question is preferred mainly because it has shown to produce more efficient estimates than those from a single question (Hanemann et al. 1991). Haab and McConnell (2002) also found that respondents often gave “protest answers” to open ended questions compared to bounded response questions. Researchers have also appreciated this method in that it helps elicit more information about WTP than the single bound method (Hanemann et al. 1991; Arrow et al. 1993).

3.8 Designing and Administering the Contingent Valuation Survey

The questionnaire used in this study mainly composed of four sections; 1) socio-economic characteristics of respondents and households; 2) water demand and use patterns; 3) willingness to pay for improved water services; 4) water conservation and sanitation practices (Appendix I). The first section of the questionnaire included detailed information about socio-economic characteristics of households such as age, household size, average household income and education level. The second section present questions pertaining current household water use sources and patterns including attitudes towards the current domestic water quality and reliability. The third part of the questionnaire presents the valuation scenario in question and willingness to pay improved water services. Finally, the last section of the questionnaire was designed to elicit water conservation and sanitation practices such as rain harvesting, water reuse and perceptions about household water utilization.

Repeated pretesting of the questionnaire was conducted through a pilot survey to about 38 households in the study areas. This was done to minimize any biases which are often associated with contingency valuation surveys. Through the pilot survey,
initial bids for the dichotomous double bound model were elicited with the use of open-ended elicitation format. Pretesting of the questionnaire also helped in redefining the hypothetical scenario to a realistic one and which is in accordance to the needs of the study. The valuation scenario thus tried to provide detailed information about the description of the proposed water project and short and long term benefits with regards to such a project. This all was verbally depicted to respondents in the course of the interview. Furthermore, the use of dichotomous double bounded elicitation enhanced to minimize strategic bias which emanates from respondents trying to influence the price to pay.

The choice of payment mechanism is important in CV studies. The payment vehicle is the mechanism through which the WTP values are to be raised. According to Mitchell and Carson (1989) the payment vehicle should satisfy five conditions and these are; familiarity, credibility, empathy, feasibility and universality. Respondents should be familiar with the payment vehicle which also has to be credible in representing a realistic situation. Empathy of the vehicle entails if the respondent is favorably or unfavorably disposed towards the recipient of the funds. Moreover, the vehicle should be feasible in ways that show the capability of the recipient of funds in delivering the improvement and as well as be universal in that it should affect all respondents or households equally important. It is therefore, for the same reason that the payment vehicle used in the study was to be through a monetary price to be paid for a 20 litre of clean potable water.
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Descriptive Statistics

4.1.1 Socio-Economic Characteristics of Households

The study used data collected from a sample of 314 randomly selected households. However for analysis; data from only 287 households were utilized as a result of spoilt and non-complete questionnaires. From the sample of 287 households, about 55% were male headed households and 45% were female headed households. Of the total sampled households, about 33% were not willing to pay the randomly pre-specified bid and 67% household were willing to pay the initial pre-specified bid. Of the 96 non-willing households, 57% were female headed and 43% were male headed. On the other hand, from the total households willing to pay the initial bid, about 39% were female headed households and 61% were male headed households.

Moreover, out of the 158 male headed households, about 26% were not willing to pay the pre-specified initial bid and the remaining 74% were willing to pay the specified initial bid for improved water. On the female headed households, 43% were not willing to pay the pre-specified bid and the remaining 57% were willing to accept and pay the initial bid for improved water as shown in Table 4.1. The table further shows the relationship between willingness to pay and marital status of the surveyed households. From the total households, 34% were non-married (Divorced and Widowed) headed and 66% were married. Out of the married household heads, 68% were willing to pay the pre-specified bid and the remaining 32% were not. Similarly,
of the non-married household heads, 63% were willing to pay the initial bid and 36% were not.

**Table 4.1** Sex, Marital status, Social Position and Household Garden of Households

<table>
<thead>
<tr>
<th></th>
<th>Non-Willing</th>
<th>Willing</th>
<th>Total</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>41</td>
<td>117</td>
<td>158</td>
<td>8.88***</td>
</tr>
<tr>
<td>Female</td>
<td>55</td>
<td>74</td>
<td>129</td>
<td>44.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96</td>
<td>191</td>
<td>287</td>
<td>100</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>36</td>
<td>129</td>
<td>189</td>
<td>0.7215</td>
</tr>
<tr>
<td>Single</td>
<td>60</td>
<td>62</td>
<td>98</td>
<td>34.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96</td>
<td>191</td>
<td>287</td>
<td>100</td>
</tr>
<tr>
<td><strong>Social Position</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
<td>52</td>
<td>65</td>
<td>6.8283**</td>
</tr>
<tr>
<td>No</td>
<td>83</td>
<td>139</td>
<td>221</td>
<td>77.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96</td>
<td>191</td>
<td>287</td>
<td>100</td>
</tr>
<tr>
<td><strong>Household Garden</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>33</td>
<td>107</td>
<td>140</td>
<td>11.98***</td>
</tr>
<tr>
<td>No</td>
<td>63</td>
<td>84</td>
<td>147</td>
<td>51.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96</td>
<td>191</td>
<td>287</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a “No” answer for the first bid while willing is a “Yes” answer for the first bid.

Social status of households surveyed was also one of the key variables used in the study. From the total households, about 23% reported to be in social positions in their
respective communities and the remaining 77% were not. In addition, from the 65 in social positions, 20% were not willing to pay the pre-specified randomly assigned bid and the other 80% were. In addition, households in the study area were also asked about the ownership of a household garden. Of the total sampled households, about 49% reported to be having a small garden in their backyard which they water using domestic water. Of those owning household gardens, only 24% were non-willing to pay the initial bid while the other 76% were willing to pay the initial bid.

Table 4.2 Age, Household Size, Income, Distance and Education of Households.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Willing</th>
<th>Willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE (Years)</td>
<td>56.77</td>
<td>51.48</td>
</tr>
<tr>
<td>HH SIZE</td>
<td>7.06</td>
<td>7.67</td>
</tr>
<tr>
<td>INCOME (E)</td>
<td>1677.99</td>
<td>2646</td>
</tr>
<tr>
<td>DISTANCE (Metres)</td>
<td>641.98</td>
<td>855.16</td>
</tr>
<tr>
<td>EDUCATION (Years)</td>
<td>5.57</td>
<td>855.16</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a “No” answer for the first bid while willing is a “Yes” answer for the first bid.

From the sampled households, the mean age was found to be 53.24 years with the maximum and minimum years being 82 and 18, respectively. Households willing to pay the initially specified bid had a mean of 51.47 years while their counterfactuals had mean age of 56.77 years. Results from a t-test revealed statistical differences between the mean ages of the two groups, willing and non-willing respondents, as shown in Table 4.2. Results further revealed that the sampled households had a total of 2144 family members. This constituted a mean of 7.47 members per household where the minimum size was 2 members and maximum was 25 members. Households willing to pay the initially specified bid had a mean household size of 7.67 members.
while those not willing had mean of 7.06. The result from the t-statistic shows that there is no statistical difference between the means of the two groups as shown by the t-value (-1.48) in Table 4.2.

Furthermore, results revealed the mean monthly household income in the study area to be E2322.20 with the minimum and maximum incomes at E100.00 and E7500.00, respectively. From the non-willing households, mean income was E1677.99 while for those willing, mean income was E2646.00. Again results from the t-test show statistical differences between the means of those willing and non-willing. Distance to water source was another important variable used in the analysis. On average, mean distance to the main water source was found to be at 783.85 metres (m), with minimum distance at 50m while maximum distance travelled at 3500m. The mean distance for willing and non-willing households was 855.16m and 641.98m, respectively. The mean difference between the two groups was statistically significant at less than 1% probability level as shown in Table 4.2.

The education level of the household head was computed as the number of years spent by the household head in school. Results showed that mean years spent in school by the heads of the sampled households to be at 7.39 years as shown in Table 4.2. Furthermore, the result also show the mean years spent in school for both non-willing and willing households to be 5.57 and 8.31, respectively. Again this showed statistical differences between the mean years of the two groups at less than 1% probability level. This result indicates that WTP tends to increase with increases in years of education.
4.1.2 Household Water Use Attributes and Perceptions

The different types of water users in Swaziland may be delineated according to their source of water used. Only an insignificant number of 8 households were found to be using private (piped) water connection and therefore were not used in the analysis. From 287 households used, about 39% reported to be using river water, about 60% using collective taps (boreholes) and less than 1% using other sources as shown in Table 4.3. Of the non-willing households, about 42% used river water and the other 58% used water from collective taps. On the other hand, of the willing households, 38% used river source, 61% used collective taps and 1% used ‘other’ sources.

Households in the study area also reported about their perception regarding the quality of water they are currently using. From the total 287 households, about 25% reported water to be ‘very poor’, 40% to be ‘poor’, 16% to be ‘just ok’, 16% to be ‘good’ and 3% reported water to be of ‘very good’ quality. In further questioning the households about water quality, households from Vimbizibuko also complained about the water from collective taps in that they are contaminated and salty. As a result, some households have chosen to abandon nearby collective taps or boreholes for distant river water.
### Table 4.3 Water Source, Water Quality, Averting Behaviours and Water Conservation for sampled Households

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Non-Willing</th>
<th>Willing</th>
<th>Total</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>40 (41.7%)</td>
<td>73 (38.2%)</td>
<td>133 (39.4%)</td>
<td>0.79</td>
</tr>
<tr>
<td>Collective Tap</td>
<td>56 (58.3%)</td>
<td>117 (61.3%)</td>
<td>221 (60.2%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
<td>1 (0.5%)</td>
<td>287 (0.4%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96 (100%)</td>
<td>191 (100%)</td>
<td>287 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>Non-Willing</th>
<th>Willing</th>
<th>Total</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. Poor</td>
<td>13 (13.5%)</td>
<td>59 (30.9%)</td>
<td>72 (25.1%)</td>
<td>37.17***</td>
</tr>
<tr>
<td>Poor</td>
<td>30 (31.3%)</td>
<td>86 (45.0%)</td>
<td>116 (40.4%)</td>
<td></td>
</tr>
<tr>
<td>Just Ok</td>
<td>20 (20.8%)</td>
<td>25 (13.1%)</td>
<td>45 (15.7%)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>31 (32.3%)</td>
<td>15 (7.9%)</td>
<td>46 (16.0%)</td>
<td></td>
</tr>
<tr>
<td>V. Good</td>
<td>2 (2.1%)</td>
<td>6 (3.1%)</td>
<td>8 (2.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96 (100%)</td>
<td>191 (100%)</td>
<td>287 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Averting Behaviour</th>
<th>Non-Willing</th>
<th>Willing</th>
<th>Total</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>14 (14.6%)</td>
<td>52 (27.2%)</td>
<td>66 (23.0%)</td>
<td>5.77**</td>
</tr>
<tr>
<td>No</td>
<td>82 (85.4%)</td>
<td>139 (72.8%)</td>
<td>221 (77.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96 (100%)</td>
<td>191 (100%)</td>
<td>287 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Conservation</th>
<th>Non-Willing</th>
<th>Willing</th>
<th>Total</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>39 (40.6%)</td>
<td>125 (35.6%)</td>
<td>164 (57.1%)</td>
<td>16.07***</td>
</tr>
<tr>
<td>No</td>
<td>57 (59.4%)</td>
<td>66 (65.4%)</td>
<td>123 (42.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>96 (100%)</td>
<td>191 (100%)</td>
<td>287 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a “No” answer for the first bid while willing is a “Yes” answer for the first bid.

Furthermore, households were also categorised by their averting behaviour practices. From the total sampled households, only 23% reported to be practicing averting behaviour measures. Of those practicing, about 21% were non-willing to pay the pre-
specified bid and the 79% were willing to pay the specified bid amount. Again this result shows the statistical differences between households practicing averting behaviours and those not practicing against WTP, as shown by chi-statistic at 5% level of significance. Households’ awareness of water conservation also had a positive association with willing to pay decision at 1% level of significance as shown in Table 4.3. Of the total sampled households, about 57% were aware and practiced water conservation and the rest did not. From those who showed awareness on conservation, only about 24% were not willing to pay the initial bid while the other 76% were willing to pay the pre-specified initial bid.

Furthermore, the 287 sampled households in the study area reported to be using on average a total of 24550 litres of water per day for household uses. The computed mean for household daily water used and per capita daily consumption for the total households was at 85.54 litres and 13.12, litres respectively. The mean daily water consumption for non-willing households was 77.7 litres and willing households was 89.5 litres. Again the result of the two groups showed statistical differences as shown by the significant t-statistic in Table 4.4.

The mean daily per capita water used for non-willing and willing households was estimated to be at 12.09 and 13.64, respectively. Again the result shows that there is a negative but statistically significant association between per capita daily water consumption and willingness to pay. Time spent, in minutes, to collect water was also estimated by households and the mean time spent reported was about 46 minutes. The mean time spent by non-willing households was 42 minutes while on the other hand,
willing households mean time spent was about 49 minutes. The result again showed significant differences between the means of the two groups as shown in Table 4.4.

**Table 4.4 Water Consumption, Time Spent, Expenditure and Trips of Households**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Willing</th>
<th>Willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH Water (L)</td>
<td>77.66 3.20</td>
<td>89.50 1.99</td>
</tr>
<tr>
<td>Per Capita Water (L)</td>
<td>12.09 0.54</td>
<td>13.64 0.52</td>
</tr>
<tr>
<td>Time Spent (Minutes)</td>
<td>41.51 2.41</td>
<td>48.48 1.95</td>
</tr>
<tr>
<td>Water expenditure (E)</td>
<td>5.15 1.16</td>
<td>4.72 0.50</td>
</tr>
<tr>
<td>No. Daily Trips</td>
<td>1.92 0.08</td>
<td>2.06 0.06</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively. Non-Willing is a “No” answer for the first bid while willing is a “Yes” answer for the first bid.

Furthermore, household also reported the daily number of trips they make to collect water from their water sources. The results show that the minimum number of trips was 0.33 (once in 3 days), while the maximum was 5 trips per day. The result from the t-test shows that there were no statistical differences between the mean number of trips per day for willing and non-willing households. The calculated mean number of trips for non-willing and willing households was estimated to be at 1.92 and 2.06, respectively.

**4.2 Willingness to Pay Estimation**

The first objective of this study was to estimate willingness to pay for improved water services in the study areas using a dichotomous choice method with a follow up question. In this method of elicitation, initial bids were randomly distributed to questionnaire. These initial bids were obtained through a pilot survey conducted prior the main survey using open-ended questions. The total sample of the pilot survey was
36 households. On the pilot survey, households were asked about the maximum amount of money they would be willing to pay for a 20 litre of clean water. Results from the pilot survey are as shown in Figure 4.1. From the pilot bids, the randomly assigned bids used were €0.10; €0.20; €0.30; €0.40; €0.50.

![Figure 4.1 Pilot survey results on WTP](image)

Source: Own Survey, 2015

From the initial bids, follow up bids were then calculated to be half the initial bid given a ‘no’ response to the first question and double the initial bid given a ‘yes’ response to the initial bid. Therefore, for a single bid offered to a respondent, there are two possible responses. Table 4.5 summarizes results from the offered bids from a double bounded dichotomous choice question.
Table 4.5 Summary of Discrete Response to the Double-Bounded Questions

<table>
<thead>
<tr>
<th>Initial Bid (LowerBid1w)</th>
<th>Follow up Bid (UpperBid2w)</th>
<th>First Question</th>
<th>Second Question</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. of ‘Yes’ to initial Bid</td>
<td>No. of ‘No’ to initial Bid</td>
</tr>
<tr>
<td>E0.10</td>
<td>E0.20</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>E0.10</td>
<td>E0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E0.20</td>
<td>E0.40</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>E0.20</td>
<td>E0.10</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>E0.30</td>
<td>E0.60</td>
<td>58</td>
<td>0</td>
</tr>
<tr>
<td>E0.30</td>
<td>E0.15</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>E0.40</td>
<td>E0.80</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>E0.40</td>
<td>E0.20</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>E0.50</td>
<td>E1.00</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>E0.50</td>
<td>E0.25</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015

In Table 4.5, the first row for each initial bid summarizes the ‘yes’ responses and the second row summarizes the ‘no’ responses to that bid. This therefore means each randomly assigned bid is summarized in two rows as per the nature of double bounded questions. The initial bid of E0.1 resulted in 19 ‘yes’ responses and zero ‘no’ response. Of the ‘yes’ responses to Bid1w=E0.1, the follow up question, Bid2w=E0.2, resulted to 18 ‘yes’ responses and 1 ‘no’ response. Similarly, the second initial bid E0.2, resulted to 53 ‘yes’ responses and 21 ‘no’ responses. Of the ‘yes’ responses to Bid1w=E0.2, the follow up question Bid2w=E0.4, gave out 30 ‘yes’ responses and 23 ‘no’ responses. Again on the 21 ‘no’ responses for Bid1w=E0.2, the follow up question Bid2w=E0.1 resulted to 20 ‘yes’ responses and 1 ‘no’ response. The third bid of E0.30 had 58 ‘yes’ responses and 22 ‘no’ responses. From the 58 ‘yes’
responses, the follow up Bid2w=E0.6, resulted to 26 ‘yes’ responses and 32 ‘no’ responses. Of the 22 ‘no’ responses to the third initial bid (Bid1w=E0.3), the follow up question with Bid2w=E0.15 gave out 14 ‘yes’ responses and 8 ‘no’ responses. The other fourth and fifth initial bids, Bid1w=E0.4 and Bid1w=E0.5, can be interpreted similarly as shown above in Table 4.5.

The study also categorized households based on the joint responses of the offered bids (Initial and follow up). Results of the joint responses are shown on Table 4.6. As can be seen, the response Yes – No occupies the largest percentage of the joint responses with 37%. Following the Yes – No response, was the Yes – Yes response with 29%, followed by No – Yes response with 26%. Finally, the joint response with least responses was the No – No response with about 7%. This result showed, generally, that households in the study areas were willing to pay for an improvement in their domestic water services.

**Table 4.6 Frequency of Joint Willingness to Pay questions**

<table>
<thead>
<tr>
<th>WTP Responses</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes – Yes</td>
<td>84</td>
<td>29.27</td>
</tr>
<tr>
<td>No – No</td>
<td>21</td>
<td>7.31</td>
</tr>
<tr>
<td>Yes – No</td>
<td>107</td>
<td>37.28</td>
</tr>
<tr>
<td>No – Yes</td>
<td>75</td>
<td>26.13</td>
</tr>
<tr>
<td>Total</td>
<td>287</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015
4.2.1 Reasons for Maximum Willingness to Pay

Sampled households were also asked about the reasons influencing their maximum WTP. Of the total households sampled, about 93% stated their reasons for WTP while the remaining 7% were categorized under ‘zero bids’ respondents. Table 4.7 shows the reasons of respondents who had a positive WTP. Of the 266 households with a positive WTP, about 87% reported to ‘desperately need the water service’ in their respective communities as their reason for maximum WTP. Households who revealed that ‘it’s a reasonable amount’ as their reason for WTP were about 7%. Finally, about 6% of the households with a positive WTP reported that they ‘can afford’ the assigned amount.

### Table 4.7 Reasons for Willingness to Pay

<table>
<thead>
<tr>
<th>Respondents’ reasons for WTP</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>We really need the service</td>
<td>232</td>
<td>87.2</td>
</tr>
<tr>
<td>It’s a reasonable amount</td>
<td>18</td>
<td>6.7</td>
</tr>
<tr>
<td>I can afford</td>
<td>16</td>
<td>6.1</td>
</tr>
<tr>
<td>Total</td>
<td>266</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015

Table 4.8 shows the reasons stated by sampled households who were not willing to pay for an improvement in their water services. Of the total 21 respondents with zero WTP, about 24% reported ‘I don’t trust local government’ as their reason of not paying. Furthermore, about 43% cited ‘its government’s responsibility’ to supply them with water as their reason. Both reasons were categorized as protest zero bids as per the criteria from the NOAA panel (Arrow et al., 1993). This made a total of about 67% and 5% protest bidders from the total zero bidders and total sample size,
respectively. Finally, of the total 21 households with zero WTP, 33% reported to not be able to afford due to being ‘unemployed and poor’ and thus were categorized as true zero bids.

Table 4.8 Reasons for Not Willing To Pay

<table>
<thead>
<tr>
<th>Respondents’ reasons for non WTP</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t local trust government</td>
<td>5</td>
<td>23.8</td>
</tr>
<tr>
<td>Its government’s responsibility</td>
<td>9</td>
<td>42.9</td>
</tr>
<tr>
<td>I am unemployed and poor, can’t afford</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Own Survey, 2015

4.3 Estimation of Parametric Mean from Double Bounded Dichotomous Choice Format

The second objective of the study was to estimate the parametric mean WTP for improved water services in the study area. As per the nature of double bounded formats, households were randomly offered an initial bid and depending on the response to the first bid, a follow up (double or half the initial bid) bid was offered. Table 4.9 presents a descriptive statistics of the bids offered and responses from households. The results from the table shows that the ‘yes’ responses from the first bid and second were about 67% and 55%, respectively. Moreover, the mean of the initial bid offered was found to be at E0.31 while for the follow up bid, mean was at E0.45 cents.
Using the dichotomous double bounded format, the parametric mean WTP was estimated for both the lower and upper bids. The study used the seemingly unrelated bivariate probit (SUBP) model as specified by Haab and McConnel (2002) and results are as shown in Table 4.10. The result revealed that both the initial bid (LowerBid1w) and the follow bid (UpperBid2w) to be statistically significant at less than 1% probability with negative signs. The result therefore indicates that the higher the initial and follow up bid, the less the probability of that bid being accepted. The result is consistent with economic theory of demand for environmental and natural goods.

As it can be seen from Table 4.10, ‘rho’ (ρ), which measures the correlation of the residuals of the two models, is 0.24 which is not close to one, thus is not statistically significant at any level. This implies that the error term of WTP for the first question is not perfectly correlated with the error term of WTP for the second question (bid). Using these coefficients in Table 4.10, the mean willingness to pay for improved water services from the double bounded elicitation format was calculated using the formula proposed by Haab and McConnell (2002) (see equation 19). The result showed that mean WTP for the initial and follow up bid to be E0.45 and E0.49,
respectively. This meant that households in the study area can pay up to E0.47 for a 20 litre of water.

Table 4.10 Estimates of the Bivariate Probit Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LowerBid1w</td>
<td>-3.002927</td>
<td>0.7460074</td>
<td>-4.03</td>
<td>0.000***</td>
</tr>
<tr>
<td>Constant</td>
<td>1.380597</td>
<td>0.2523819</td>
<td>5.47</td>
<td>0.000***</td>
</tr>
<tr>
<td>UpperBid2w</td>
<td>-3.251243</td>
<td>0.5607972</td>
<td>-5.80</td>
<td>0.000***</td>
</tr>
<tr>
<td>Constant</td>
<td>1.585703</td>
<td>0.2543797</td>
<td>6.23</td>
<td>0.000***</td>
</tr>
<tr>
<td>Athrho</td>
<td>0.2456473</td>
<td>0.2257557</td>
<td>1.09</td>
<td>0.277</td>
</tr>
<tr>
<td>Rho (ρ)</td>
<td>0.2408227</td>
<td>0.2126629</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Log likelihood = -333.0551
Number of Observations = 287
Wald chi2(2) = 47.32
Prob > chi2 = 0.0000

Likelihood-ratio test of rho=0: chi2(1) = 1.28435 Prob > chi2 = 0.2571

Source: Own Survey, 2015 *** Significant at less than 1%

4.4 Determinants of Willingness to Pay

The third objective of the study was to identify the determinants of willingness to pay, which is, willingness to pay the pre-specified initial bid presented for improved domestic water in the study area. A probit model was used in the analysis where the dependent variable (WTP) was binary taking values of 1 for ‘willing’ and 0 for ‘not willing’. Other variables were included in the model as independent variables. This included both dummy and continuous variables which were households’ socio-economic variables, perceptions and other practices related to water use.
Prior to the probit model, a Linear Probability Model (LPM) was run using OLS regressors. From the LPM, the Ramsey specification was run to test for misspecification in the model and results showed no signs of misspecification (Appendix II). Furthermore, pair-wise correlation was performed on variables and perfectly correlated variables were dropped from the model. Multicollinearity was then tested using VIF and the result again virtually showed no signs of multicollinearity as the VIF values were far less the 10 threshold (Appendix III). The Contingency Coefficient (CC) for dummy variables was used to test for association amongst dummy independent variables used in the model and results showed no serious associations (Appendix IV).

After the tests were performed, the probit model was run and results are as shown in Table 4.11. In the probit model, the chi-square ($\chi^2$) distribution is used as the measure of overall significance of a model in probit model estimation. The result from the probit model shows that the explanatory variables included in the model fits the model at less than 1% probability level. This is showed by the chi-square value of 104.62 with 11 degrees of freedom. Generally, this result from the probit model showed that the variables used in the model, fit the model very well.

It is, however, worth mentioning that the parameter estimates of the probit model provide only the direction and not the magnitude of the effect of the independent variables on the dependent variable. It is therefore important to calculate marginal effects after the probit model to explore the magnitude effect of the explanatory variables. Marginal effects measure the expected change in probability of a particular choice being made with respect to unit change in an explanatory variable (Greene,
The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients. The marginal effects of the probit model estimation results are also reported in Table 4.11.

A total of 11 explanatory variables were used in the analysis as a result of endogenous and correlated variables being dropped. Furthermore, variables not contributing to the log-likelihood of the model were left out. From the 11 explanatory variables used, 8 variables were significant at less than 5% level as shown in Table 4.11.

Table 4.11 Probit and Marginal Effect Results for Willingness to Pay

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Error</th>
<th>Z-value</th>
<th>Marginal effects</th>
<th>Z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.0164**</td>
<td>0.0071295</td>
<td>-2.29</td>
<td>-0.0055**</td>
<td>2.30</td>
</tr>
<tr>
<td>Gender</td>
<td>0.5274***</td>
<td>0.1818199</td>
<td>2.90</td>
<td>0.1768***</td>
<td>2.91</td>
</tr>
<tr>
<td>S. Position</td>
<td>0.3013</td>
<td>0.2272916</td>
<td>1.33</td>
<td>0.0957</td>
<td>1.41</td>
</tr>
<tr>
<td>EduLevel</td>
<td>0.0379**</td>
<td>0.0182473</td>
<td>2.08</td>
<td>0.0127**</td>
<td>2.08</td>
</tr>
<tr>
<td>HHIncome</td>
<td>0.0002***</td>
<td>0.0000621</td>
<td>2.82</td>
<td>0.0001***</td>
<td>2.82</td>
</tr>
<tr>
<td>Waterused</td>
<td>0.0045</td>
<td>0.003195</td>
<td>1.40</td>
<td>0.0015</td>
<td>1.40</td>
</tr>
<tr>
<td>WaterQuality</td>
<td>-0.2311***</td>
<td>0.0831678</td>
<td>-2.78</td>
<td>-0.0775***</td>
<td>2.77</td>
</tr>
<tr>
<td>AvertingB.</td>
<td>0.3126</td>
<td>0.2258062</td>
<td>1.38</td>
<td>0.0991</td>
<td>1.48</td>
</tr>
<tr>
<td>Distance</td>
<td>0.0006***</td>
<td>0.0002273</td>
<td>2.84</td>
<td>0.0002***</td>
<td>2.91</td>
</tr>
<tr>
<td>HHgarden</td>
<td>0.5640***</td>
<td>0.1818845</td>
<td>3.10</td>
<td>0.1866***</td>
<td>3.19</td>
</tr>
<tr>
<td>LowerBid1w</td>
<td>-2.2356**</td>
<td>0.8612673</td>
<td>-2.60</td>
<td>-0.7494**</td>
<td>2.59</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.1244</td>
<td>0.6865627</td>
<td>-0.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Log likelihood = -130.70425
Number of observations = 287
LR chi2(11) = 104.41
Prob > Chi2 = 0.0000
Pseudo R2 = 0.2854

Source: Own Survey, 2015. *** & ** Significant at less than 1% and 5% respectively.
Age of household head (Age): The age of the household head proved to be significant and negatively associated with WTP for improved water service at less than 5% probability level. The negative association between WTP and age of the household head means that as age increase, the probability of a respondent saying ‘yes’ decrease and vice versa. Similarly, the marginal effect result also had a negative sign. This basically implies that, holding all other variables constant at their means, a one year increase in the age of the household head reduces the probability of accepting the initial bid by 0.55%. This result therefore indicates that younger household heads are more willing to pay for improved domestic water than older heads in the study area. This result was not in line with the findings of Farolfi et al. (2007) but consistent with the findings of Ogunniyi et al. (2011) and apriori expectations.

Gender of household head (Gender): In contrast to age, the probit result for gender of the household head also showed to be significantly related to WTP however with a positive sign. The binary nature of the gender variable (Female=0: Male=1) showed that male headed were more willing to pay for improved water services than their female counterparts. Moreover, the marginal effect result for gender was also significant at 1% probability level with a positive sign. This result showed that, keeping other variables constant at their mean values, being male increases the probability of accepting the initial bid by 17.7%. This result however was not consistent with apriori expectations. This is because since it’s the women who carry the burden of water collection in most rural households, it was expected that they will be more willing to pay than males. However, the result may be so because in
Swaziland, males are regarded to be the heads hence responsibilities or decisions of making any payments rely upon them, other than females. This result again was not in consonance with the findings of Farolfi et al. (2007).

**Social Position (S. Position):** The social status of the household head in the community was also included in the analysis. It was expected that heads in social positions would be more willing to pay for an improvement in the community’s water services. This was mainly because being in social (leadership) positions inspires some form of social responsibility, thus being more willing to pay for community driven development such as an improvement in community water services. Both the probit and marginal effects results reported no significant association between WTP and being in a societal position, however, had the *apriori* expected positive sign.

**Level of education (EduLevel):** Education level of household head was another important variable explaining WTP for improved water services. The probit result proved to be consistent with *apriori* expectations as the variable took a positive sign and was significant at 5% probability level. This showed that increases in levels of education increases the probability of households’ willingness to pay decision. The marginal effects of the probit model also showed that education of household head significantly and positively affect the probability of WTP. This result implied that, keeping other factors constant at their mean values, a one year increase in the education level of the household head increases the probability of WTP by 1.3%. This can be mainly because more educated household heads are more aware with the importance of clean water utilization hence are more willing to pay for an
improvement in such a service. The result was true with the findings of Kanayo et al. (2013); Ogunniyi et al. (2011) and Akter, (2007).

**Household Income (HHIncome):** Average monthly income of households was another strong factor of WTP. This was shown by the positive coefficient and statistical significance at less than 1% probability level on the probit result. Similarly, the marginal effect result for household income showed a positive and significant relationship with households’ WTP. This meant that, keeping the influences of other factors constant at their mean values, a one lilangeni\(^3\) increase in household income increases the probability of accepting the first bid in by about 0.001%. Generally, this implies that an increase in income of a household shifts the demand curve for clean and potable water to the right. This result was in-line with the *apriori* expectations of the study and economic theory as higher income families have better chances of maximizing utility and enjoy better and high quality goods. The result was also true with the findings of Khan et al., (2010); Farolfi et al. (2007); Ogunniyi et al. (2011) and Kanayo et al. (2013).

**Water Consumption (Waterused):** The amount of water, in litres, used per day in a household was used in place of daily water per capita consumed. This was mainly because the latter variable showed signs of endogeniety in the model. The effect of the quantity of water consumed was not significant influencer on WTP. The variable was not significant; however, had a positive sign on both the probit and marginal effect estimates which was not in line with *apriori* expectations of the study.

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\(^3\)Lilangeni is singular for Emalangeni, Swazi currency.
**Water Quality (WaterQuality):** The quality of water as observed by the households also proved to be influencing WTP. The result implied that the higher the quality households perceive their current water to be, the less they are willing to pay for water. This was mainly so because of the negative sign on the coefficient and statistically significant p-value at 1% probability level. This is not a strange result given the disutility a household would endure if current water used is of compromised quality. The marginal effect result on water quality also maintained the same sign and significance level. Keeping all other factors constant, a unit increase in the quality of water as perceived by households, lowers the probability of saying ‘yes’ by 7.8%. This result is in line with *apriori* expectations as it is rational human behaviour that households using safe water may be satisfied and thus not willing to pay more for a similar good.

**Averting behaviours (AvertingB.):** Awareness of the importance of using clean water encourages households to practice preventive measures on water before consumption. Such measures included boiling, refrigerating, use of chemicals and others. Households practicing such measures showed to be more willing to pay than households not practicing such measures. The result, however, was not significant but still had the *apriori* positive sign. This result was once again true with the findings of Farolfi et al. (2007).

**Distance to water source (Distance):** Distance to water source was also another important variable explaining household’s WTP for improved water services. The result showed that the further the distance travelled, the higher the disutility to the household involved. The result was significant at 1% probability level with an *apriori*
positive sign. Similarly, the marginal effect coefficient was also positive and statistically significant. This thus implies that households who travel long distances to fetch water are more likely to be willing pay for an improved and nearer water source as compared to their counterparts. Holding all other factors constant, a one meter increase in the average distance travelled by households increases the probability of WTP by 0.02%. Again this is not a strange result considering the cost of labour and time involved in longer distances; hence a closer source would be preferred. The result was also in line with the findings of Kanayo et al. (2013).

**Household Garden (HHGarden):** Ownership of a small garden in a household was also another influencing factor to WTP. This is shown by the significant p-value and the positive sign, suggesting that households owning gardens in their backyard were more willing to pay than their counterparts. The marginal effects also reported a similar result. This meant that a household owning a garden has a higher probability of accepting the initial bid by 18.67% *ceteris paribus*. The result was true to the *apriori* expectations of the study as household gardens are one vital form of enhancing both food security and nutrition levels in households. Therefore, households owning gardens are aware of that and would appreciate a closer source of water to enhance their production.

**Initial Bid (LowerBidw):** Finally, the bid offered to households had a negative sign and statistical significance as economic theory predicts. The bid was found to be significantly associated with WTP at 1% probability level. The marginal effect result also showed a similar sign and statistical significance. This implied that, holding other factors at their mean values, an E0.10 increase in the bid offered to households
decreases the probability of accepting it by 74.85%. The result was consistent to economic theory of demand, in that the higher the price of a good, the less the demand and vice versa.

4.5 Factors affecting household water consumption

Finally, the last objective of the study was to identify the determinants of per capita water consumption. Using the double-log regression model, the log of daily household water used per capita in litres, was used as the dependent variable explained by ten explanatory variables. These included marital status of household head, sex of household head, ownership of a water tank, number of trips taken per day to collect water, log of education years of household head, log of the age of household head, log of household income, log of distance travelled to collect water, the log of household size and log number of years using water source.

For this objective, the study used the multiple linear regression model. However, given the number of assumptions classical regressions models are subjected to, if testing reveals that some particular assumptions are not satisfied, then some alternative to the straightforward application should be resorted to. One of such an alternative may include transforming the data by either logarithmic, reciprocal, square root, square, reciprocal or arcsin transformation. In our model, data suggested both non-constant variance and non-linearity condition on the errors and regression coefficients, respectively. It was, therefore, for that reason that a transformation of the model to a double-log model was chosen to control both for non-constant variance and non-linearity.
A preliminary analysis of variables was conducted to ensure that the variables included in the model explain the dependent variable and are not highly correlated. Highly correlated and irrelevant explanatory variables were dropped from the model. The results from the correlation matrix of variables used in the model show that there were no signs of highly correlated variables reaching the standard rule of thumb 0.7. In addition, variables were also tested for multicollinearity using the VIF test and again results showed no signs of multicollinearity problem (Appendix V).

Table 4.12 show the results obtained from the regression model. The value of $R^2$ indicates how much of the variance in the dependent variable (Daily per capita water consumption) is explained by the model. The variance explained was found to be 0.5581 which implied that the explanatory variables included in the model were only able to explain about 56% of variance in daily per capita water demand. The F-test shows that the overall model is significant at less than 1% probability level. This showed that the model was correctly specified. Furthermore, post estimation test of the Ramsey test showed that the model is not under specified.

**Marital Status (MaritalStatus):** The results show that the marital status of the household head does not affect household per capita water used. The variable was not significant at any level of significance; however, had a negative sign. The result was not in-line with *apriori* expectations as a positive sign was expected. Furthermore, the sex of household head (Gender) was also not statistically significant at any level, however had a positive sign.
Table 4.12 Double-log Regression Analysis for Water Consumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Std. Err.</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaritalStatus</td>
<td>-0.0611</td>
<td>0.0396107</td>
<td>-1.54</td>
<td>0.124</td>
</tr>
<tr>
<td>Gender</td>
<td>0.0325</td>
<td>0.0370541</td>
<td>0.88</td>
<td>0.382</td>
</tr>
<tr>
<td>WaterTank</td>
<td>0.1397***</td>
<td>0.0372062</td>
<td>3.75</td>
<td>0.000</td>
</tr>
<tr>
<td>LnNo.oftrips</td>
<td>0.0266</td>
<td>0.0431156</td>
<td>0.62</td>
<td>0.537</td>
</tr>
<tr>
<td>LnEduLevel</td>
<td>0.0655***</td>
<td>0.0205867</td>
<td>3.18</td>
<td>0.002</td>
</tr>
<tr>
<td>LnAge</td>
<td>0.0716</td>
<td>0.0701973</td>
<td>1.02</td>
<td>0.309</td>
</tr>
<tr>
<td>LnHHIncome</td>
<td>0.1331***</td>
<td>0.026685</td>
<td>4.99</td>
<td>0.000</td>
</tr>
<tr>
<td>LnDistance</td>
<td>-0.0499*</td>
<td>0.0274865</td>
<td>-1.81</td>
<td>0.071</td>
</tr>
<tr>
<td>LnHHSize</td>
<td>-0.7330***</td>
<td>0.0425772</td>
<td>-17.22</td>
<td>0.000</td>
</tr>
<tr>
<td>LnYearsusingsource</td>
<td>-0.0470**</td>
<td>0.0225221</td>
<td>-2.08</td>
<td>0.038</td>
</tr>
<tr>
<td>Constant</td>
<td>2.8340</td>
<td>0.3895397</td>
<td>7.28</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Number of Observations = 287
F (10, 276) = 34.85
Prob > F = 0.0000
R-squared = 0.5581
Adjusted R-squared = 0.5420
Root MSE = 0.30477
Breusch-Pagan test for heteroskedasticity Prob > chi2 = 0.3560
Mean VIF = 1.09
Source: Own Survey, 2015. ***, ** & * Significant at less than 1%, 5% & 10%, respectively.

Water Tank (WaterTank): Ownership of a water tank in a household showed to be an important factor on water consumption. The variable was statistically significant at less than 1% level of significance with a positive sign. This meant that households owning a water tank consume more water per capita than their counterparts. Holding the effect of other variables constant, a change in a household from ‘not owning a water tank’ to ‘owing a water tank’ increases the mean water consumed per capita by
15% \( (e^{0.1397} - 1) \). This result was in line with \textit{apriori} expectations of the study and with the findings of Cheesman et al. (2008), and Nauges and van den Berg (2009).

**Number of Trips (LnNo.oftrips):** The variable, number of trips taken by a household to collect water on daily basis was not a significant factor of per capita water consumed, however, had the \textit{apriori} expected positive sign.

**Level of Education (LnEduLevel):** The number of years attending school by the household head proved to be another strong factor influencing per capita water consumed. The variable was significant at less than 1% level with a positive sign. This implies that a 1% increase in the level of education by the household head increases daily water per capita consumed by 0.1\%, \textit{ceteris paribus}. The result was true with economic theory in that increases in education levels means increases in incomes thus increased demand for goods like domestic water. The result was also true to the \textit{apriori} expectations of the study.

**Household income (LnHHIncome):** Household income was another important variable explaining daily water per capita consumed. Results from the table showed that income was statistically significant at less than 1% level of significance and positively associated with daily per capita water consumption. This meant that, holding other factors constant, a 1% increase in household income will increase per capita water consumed by 0.13\%. This result was again in-line with both \textit{apriori} expectations and economic theory.
**Distance to water source (LnDistance):** Results from the study further showed that distance to water source was significantly associated with per capita water consumption, however, with a negative sign. The variable was statistically significant at 10% level of significance and also in line with *apriori* expectations of the study. Holding the effect of other variables constant, a 1% decrease in the distance travelled to collect water will increase per capita water demand by 0.05%.

**Household size (LnHHSize):** The size of the household had a strong influence on the dependent variable, daily water per capita consumed. This was shown by the large t-value. The variable was negatively and significantly explaining water demand at less than 1% probability level. This means that a 1% decrease in household size increases water consumed per capita in the household by 0.73%, *ceteris paribus*. The result was not true with *apriori* expectations as increases in household size can increase levels of water consumed. This was not strange in that during the survey, due to water scarcity, some households highlighted that they are only allowed up to a standard quantity of water per day regardless of household size. This was mainly because water from community boreholes were of limited quantity and usually get dried off. Therefore, to accommodate all households in the community with water, quantity standards on water collected were set. Moreover, the result was true with the findings of Nauges and van den Berg (2006) for non-piped water in Sri Lanka, another developing country like Swaziland.

**Number of years using water source (LnYearusingsource):** Lastly, the variable number years of using current water source was also found to be statistically significant to per capita water use at less than 10% level with a negative sign. This
implied that, a 1% increase in the number of years a household using the same water source decreases per capita water consumed by 0.05%, holding other factors constant.
CHAPTER FIVE
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of findings

The main objective of the study was to quantify both willingness to pay for improved water and household water per capita demand in the Lubombo and Lowveld regions of Swaziland. The results from the study showed that about 67% of the surveyed households were willing to pay the initial stated bid while the other 33% were not. Generally about 93% of the surveyed households were willing to pay something for the improvement in water services. On the other hand, mean per capita water consumed was found to be 13.12 litres which is way below the minimum standard of 25 litres/head/day, reported by Emmett and Rakgoadis (1993), proving that indeed the study areas are subjected to water stress.

The second objective of the study was to estimate the parametric mean willingness to pay for improved water services using the dichotomous double bounded elicitation format. For this objective, the study used the seemingly unrelated bivariate probit model. Results showed that both bids offered to households were significantly associated with households’ WTP decision negatively. This result was consistent with economic theory. Furthermore, the estimated mean WTP for improved water per 20 litre from the model was found to be at E0.47. This showed that households in the study area are willing to pay for an improvement in their water services with a price which can accommodate a cost recovery mechanism.

The third objective of the study was to assess the determinants of willingness to pay for water in the study areas. A probit model was used to assess the determinants of
WTP for improved water using 11 explanatory variables. Results showed that age of household head (Age), current water quality (WaterQuality) and the initial bid offered (LowerBid1w) was significantly and negatively influencing WTP. On the other hand, sex of the household head (Gender), year of education of the household head (EduLevel), average household monthly income (HHIncome), distance to water source (Distance) and ownership of a back-yard garden (HHgarden) were positively and significantly affecting household WTP decision for improved water.

Finally, the last objective of the study was to assess the factors affecting per capita daily water consumption. The study employed the double-log linear regression model in answering the objective. Results from the model showed that per capita water consumed was significantly and positively affected by the education level of the household head (LnEduLevel), average household income (LnHHIncome) and ownership of a water reservoir (WaterTank). On the other hand, household size (LnHHHsize), distance to collect water source (LnDistance), and the number of years using current water source (LnYearsusing) were negatively and significantly influencing daily per capita water consumption.

5.2 Conclusions

Water is the most valuable natural resource for humans. Without water, our society, our economy and our lives are compromised. With water resources being under substantial pressures from various human activities and needs, conservational measures are important if future generations are being envisaged (Agudelo, 2001). It is therefore important for human kind to conserve such a resource in face of increased demand due to increases in incomes and populations. For this reason, the study used
both stated preference and utility data approaches in an effort to assess the demand side for domestic water services in the study area. Three models, bivariate probit model, probit model and double-log regression model, were estimated using household level data to address the study objectives and questions.

Households’ WTP shows that there is room for policies or projects aimed at improving rural domestic water using a water price system that can be used for both cost recovery and demand management purposes. This is important particularly because of the change in water demand management from a supply oriented approach to a demand oriented approach for water demand management in the study areas. Households in the study areas showed that they are capable of paying an amount of up to €0.47 for a 20 litre of clean potable water. The implication of this is that partial recovery on investment costs and operating costs required for sustainability of the project can be achieved through the introduction of water tariffs.

The results from the study further showed that socio-economic factors such as gender, household size, household income, education, distance, water quality and others are responsible for both households WTP decision and water consumed. It is, therefore, important for policy and water managers to address the water problem in these areas having taken into consideration these important characteristics affecting water demand. Therefore, the study findings concluded that WTP for improved water and per capita water consumption depends on both consumers’ and product sensory attributes.
5.3 Recommendations

Based on the study findings, the study recommends the following points which need to be considered in the planning and implementation of the water project in these areas.

- Both water demand techniques (stated preference and survey utility) used in the study showed that residents in the study areas were concerned with the availability and quality of water. It is for that reason that households in the study areas were willing to pay an amount of up to €0.47 per 20 litre of water. This amount translates to about €0.02 cents per litre of water. Therefore, this shows that there is room for improving semi urban and rural water services through a cost recovery mechanism. Thus, as the proposed project introduces a demand driven approach for water management to these areas, there is room to increase coverage of rural water schemes with the potential of charging even a higher price of water.

- The results from the study showed that family size negatively affects per capita household water consumed. This shows the extent of water scarcity in the study areas hence government should look into it that the proposed water project is implemented. This water project has the potential to uplift rural livelihoods in the sense that with more water, households can use the water for non-domestic purposes like backyard garden irrigation, livestock rearing, traditional beer production, etc., which can enhance households’ income thus reduce poverty.
Furthermore, household income and education level both positively influenced WTP and water consumption in the study areas. This therefore implies that for successful implementation of the project, a subsidy targeted for the poor coupled with an educational program to enhance their knowledge on the importance of safe water use is required.

The results from the study also showed that distance from water sources significantly and positively influenced WTP. Adding to that, distance to water source also statistically and negatively affected household water consumption. This therefore shows that households travelling long distances to collect water were more willing to pay for water as the distance affects their current consumption negatively. There is therefore a need for the upcoming water project in the study areas to decentralise the kiosk centres targeting households travelling longer distances for water.

5.4 Areas of Further Research

The study estimated the demand side for improved water services in the study areas; however, there are further two areas of interest to the researcher which can possibly be an extension to the study and thus inform policy accordingly. These extensions are as follows;

- Given the proposed water project in these study areas, it would be virtuous to know if households in these areas can assist government in-terms of project implementation. This could be willingness to pay for the water project, and
could be through human labour or community monetary contributions. Such knowledge can enhance planning processes while also diverting government expenditures to other national priorities.

- The study used CV method in estimating willingness to pay in the study areas. Other estimations techniques like travel cost method (TCM) and averting behaviour method (ABM) can further be used to compare the values of WTP. This would further give the same water managers more scope on WTP and on the setting of a socially acceptable price of water.
REFERENCES


APPENDIX I: SURVEY QUESTIONNAIRE

This questionnaire has been prepared to gather information about the water problem in the area. The main objective of questionnaire is to gather information on household willingness to pay for improved water services and household water demand. From the gathered information, the study aims at identifying the socio economic and institutional factors affecting both household willingness to pay and water demand in the study areas, mainly in Somnotongo, Siphofaneni and Matsanjeni constituencies (Tinkhundla). Such studies will enable the concerned bodies in the water supply sector to acquire pertinent information for sound and informed decision making in their efforts of water demand management and expanding services with increased demand. To this end, your willingness and cooperation to give honest information is valuable for the success of the research project. Thank you in advance for your time, help and cooperation.

Interview code: ________________________________

Interview date: ________________________________

Start time: ________________________________

Finish time: ________________________________

Name of community (Chieftaincy): ________________________________

Name of constituency: ________________________________

Participant’s gender: ________________________________
SECTION ONE: BACKGROUND PROFILING

1.1 Interviewee’s name or surname? _____________________________

1.2 Sex of respondent?

1 = Female  
2 = Male

1.3 Are you the HEAD of this household?

1 = Yes  
2 = No

If NO to Q1.3 how are you related to the head of this household?

1 = Spouse  
2 = Son  
3 = Daughter  
4 = Other (specify) ______________

1.4 What is your marital status (of household head)?

1 = Single  
2 = Married  
3 = Divorced  
4 = Widowed  
5 = Other (specify) __________

1.5 What is your age (of household head)? _______________

1.6 Do you have any social position in the Community?

1 = YES  
0 = NO

If YES, please specify___________________________________________

1.7 What is the total number of people living in the household?

____________________

➢  How many children are under <10: ______________

1.8 What is the highest education you attained___________ (in years spent in school)?

1.9 Indicate the level attained

• Never attended school

• Primary Education
• High School Education
• College: (specify)__________________
• Other (specify)__________________

1.10 Did you receive any formal/professional training?
1= YES  0 = NO

1.11 If YES to Q1.10 what training did you receive? (Specify)______________

1.12 From the following select one that describes your current employment status?
1= formally employed Professional (teacher, government worker, administration, health worker, clerical)
2= informally employed skilled laborer (tailor, wood work, metal work, farmer, etc)
3= unemployed/not working/pensioned
4= other (specify) ________________________________

1.13 Summary of Income sources

Below please review ALL your income sources and amounts you earn per month including SPOUSE/PARTNER or ANY family member staying with you and contributing to the household.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) On average, how much (in Emalangeni) does the household head earn from employment/own business/farm per month?</td>
<td></td>
</tr>
<tr>
<td>b) On average, how much (in Emalangeni) does spouse earn from employment/own business/farm per month?</td>
<td></td>
</tr>
<tr>
<td>c) On average, how much (in Emalangeni) do other family members contribute to the household per month?</td>
<td></td>
</tr>
<tr>
<td>d) How much (in Emalangeni) is the total monthly income is from employment/own business/gifts and any other source in the Household?</td>
<td></td>
</tr>
<tr>
<td>e) How much (in Emalangeni) is the average monthly expenditure of the Household?</td>
<td></td>
</tr>
</tbody>
</table>

SECTION TWO: WATER DEMAND AND USE PATTERNS
2.0 What is your HHs source of water supply?

1= Private tap  2= collective tap  3= river  4= vendors  5= Rain
6= other (specify) ___________

2.1 What is the HHs secondary source of water supply?

1= Private tap  2= collective tap  3= river  4= vendors  5= Rain
6= other (specify) ___________

2.2 How far is your water source from your home (consider round trip)?

________________km

2.3 For how long have you been using the source? _________________________

(years)

2.4 What means of transport do you use for collecting water?

1= By foot  2 = Car  3 = Donkey  4 = Bicycle  5 = Other (specify) ___________

2.5 How often do you collect water (no. of trips) per day _____________________Or

per week ____________________

2.6 How much time is spent on water collection per trip? _____________________

(minutes)

2.7 Who usually collects the water from water source?

1= Husband  2 = Wife  3 = Husband & wife  4 = Husband & wife & children

5= Children  6 = Other (specify) ____________________

2.8 How is water carried home from the collective tap? Type of container/Bucket

1= (10L)  2 = (20L)  3 = (25L)  4 = Other (specify) ____________________

2.9 Number of containers used per trip (tick)?

o  1
o  2
o  3
2.10 How much water on average do you use per day on household activities? ________ (litres)

2.11 Do you own a backyard garden in the household?
1= Yes  2 = No
If yes, continue to 2.12 and if no, continue to 2.13

2.12 How much water on average do you use in the garden per day? ________ (litres)

2.13 What is the largest single use of water in the household? ____________________

2.14 Do you pay for the current water services?
1= Yes  2 = No
If yes, continue to 2.14 and if no, continue to 2.15

2.15 How much on average are you paying per month for current water supply services? ________________

2.16 Do you consider this payment too high for the service provided?
1= Yes  2 = No

2.17 How would you rate the reliability of your current primary water source?
1= Very good  2 = Good  3 = Just ok  4 = Poor  5 = Very poor

2.18 Do you practice any averting behaviors before using the water? (e.g. boiling/treating)
1= Yes  2 = No

2.19 How would you rate the quality of the water from your current source?
1= Very good 2 = Good 3 = Just ok 4 = Poor 5 = Very poor

2.20 Do you own a water reservoir (Water Tank) in the household?
1= Yes 0 = No

If ‘Yes’ to 2.20 continue to 2.21, if ‘no’ continue to 2.22

2.21 Size of water reservoir?_____________ (litres)

2.22 What is your most preferred water source?
1= Private tap 2= collective tap 3= river 4= vendors 5= Rain
6= other (specify) ________________

2.23 Reason/s for choice of water source?
_____________________________________________________________________
_____________________________________________________________________

2.24 What are the reasons of not having a private water connection?
1 = not wanting the service
2 = inability to pay connection charges
3 = service is expensive
4 = because the service is not available
5 = other reasons (please specify)
___________________________________________

SECTION THREE: WILINGNESS TO PAY

3.0 Hypothetical scenario

For years residents in this community have raised serious concerns regarding the quality of water, water provision or the lack of both. As a result the European Union (EU) through the Government of Swaziland (GoS) and Swaziland Water Services Cooperation (SWSC) is considering undertaking a water project in the community
that will result to an improved water supply to the community through an introduction of a price to be charged to ALL local households regardless. This water project will involve extending water closer to households in the community through kiosk centers. This will bring about several advantages: it will save you the labour to travelling long distances to collect water, at times, without success. It will also save you the cost of buying water at higher prices from tanker trucks or other retail vendors. However, before initiating this project, the local authority is to hold a referendum where you are required to vote freely either for or against the proposed project. Voting for the initiation of the project will result in an improvement in water quality and/or provision of water services but at a COST. Voting against the initiation of the project will see you not sacrificing any payment but maintain the current status quo. Please keep in mind your personal income constraints your necessary expenses and labor shortage when answering the question. Do you understand the scenario so far?

1 = YES (if so proceed to Q 3.1)

2 = NO (if so repeat Q 3.0 until respondent understands)

3.1 How would you vote?

- Vote YES for the project to take place
- Vote NO for the project not to take place (proceed to Q3.3)

3.2 In accessing the water, the local council/authority will charge a 20 litre of water at a fee/levy of **E0.10/0.20/0.30/0.40/0.50.** This fee will be used to maintain and run the water project which will enhance sustainability. Would you be willing to pay this amount?

1= YES 0 = NO

If yes to question 3.2, proceed to 3.3. If no, proceed to 3.4.
3.3 Would you be willing to pay €0.20/0.40/0.60/0.80/1.00?

3.4 Would you be willing to pay €0.05/0.10/0.15/0.20/0.25?

3.5 If you vote NO to Q3.2, what are the reasons? (tick)

- Government’s responsibility
- Unemployed and too poor
- Too sick to participate
- Don’t trust the government
- Other ______________________________

3.6 If you vote YES to Q3.2, what are the reasons? (tick)

- Need the service
- Can afford
- It’s a reasonable amount
- Other __________________

SECTION FOUR: WATER CONSERVATION AND SANITATION PRACTICES

4.1 Have you heard about water conservation?

1= Yes  2 = No

4.2 Would you mind to talk what you know about water conservation?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

4.3 What are your sources of information about water conservation?

1= Raido  2 = Television  3 = Internet  4 = Newspapers
5= Other (specify) _________________________

4.4 Do you collect rain water during the rainy season?
1= Yes 2 = No

4.5 If your answer to the above question is yes, for what purposes do you use the rain water?
1= Drinking 2 = Washing 3 = Agriculture use 4= other (specify) __________

4.6 Do you feel that there is water wastage in the household?
1= Yes 2 = No

4.7 Have you ever remind your family members of using water economically?
1= Yes 2 = No

4.8 Does the household recycle/reuse water?
1=Yes, how? ________________________________
2=No, why? ________________________________

4.9 How many times do people in the household take a bath per day? __________

4.10 What do you use in taking a bath?
   o Shower
   o Bath-tub
   o Basin
   o Other (specify) ________________

4.11 On average, how much water do you use when taking a bath? ____________
   (litres)

4.12 Type of toilet used in the household?
   o Pit latrine
   o Flush toilet
4.13 What is your main source of information about sanitation practices?

- NGOs
- Extension workers (baggagucuteli)
- Faith based organizations (like Churches)
- Radio
- Television
- Other (specify)________________________________
APPENDIX II: VIF Stata output for Explanatory Variables used in Probit Model

```
APPENDIX II: VIF Stata output
Stata output for Explanatory Variables used in Probit Model

Variable    VIF    1/VIF
HHwaterused 1.5    0.870925
HHIncome    1.14   0.880641
EduLevel    1.13   0.882813
WaterQuality1.12   0.890267
Avertingbe~r1.07   0.937829
SocialPosi~n1.06   0.939556
Distance    1.06   0.944268
Age         1.06   0.947738
Gender      1.05   0.954171
LowerBidlw  1.05   0.955009
HHgarden    1.03   0.974506

Mean VIF  1.08
```

APPENDIX III: Stata results for Ramsey Specification Test for LPM

```
APPENDIX III: Stata results for Ramsey Specification Test for LPM

APPENDIX IV: Contingency Coefficient for Discrete Variables

<table>
<thead>
<tr>
<th>AVERT TANK</th>
<th>S.POSI Variable ING B.</th>
<th>HHGAR SEX</th>
<th>MARITAL TION</th>
<th>DEN</th>
<th>WATER STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. POSITION</td>
<td>0.128</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HHGARDEN</td>
<td>0.002</td>
<td>0.000</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARITAL S.</td>
<td>0.034</td>
<td>0.260</td>
<td>0.064</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>WATER T.</td>
<td>0.001</td>
<td>0.005</td>
<td>0.003</td>
<td>0.026</td>
<td>1.000</td>
</tr>
<tr>
<td>AVERTING B.</td>
<td>0.063</td>
<td>0.167</td>
<td>0.007</td>
<td>0.152</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Prob > F = 0.1341
```

APPENDIX IV: Contingency Coefficient for Discrete Variables
APPENDIX V: VIF Stata output for Explanatory Variables used in Double-log Model

```
. vif

<table>
<thead>
<tr>
<th>Variable</th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnEduLevel</td>
<td>1.14</td>
<td>0.873847</td>
</tr>
<tr>
<td>lnNoofTrips</td>
<td>1.14</td>
<td>0.874644</td>
</tr>
<tr>
<td>lnHHIncome</td>
<td>1.13</td>
<td>0.884203</td>
</tr>
<tr>
<td>lnDistance</td>
<td>1.13</td>
<td>0.887299</td>
</tr>
<tr>
<td>lnHHSIZE</td>
<td>1.10</td>
<td>0.910108</td>
</tr>
<tr>
<td>MaritalStatus</td>
<td>1.09</td>
<td>0.917296</td>
</tr>
<tr>
<td>lnAge</td>
<td>1.06</td>
<td>0.944337</td>
</tr>
<tr>
<td>Gender</td>
<td>1.05</td>
<td>0.952582</td>
</tr>
<tr>
<td>WaterTank</td>
<td>1.04</td>
<td>0.963241</td>
</tr>
<tr>
<td>lnYearsusi~e</td>
<td>1.03</td>
<td>0.971717</td>
</tr>
</tbody>
</table>

Mean VIF                | 1.09 |
```

APPENDIX VI: Stata output for Ramsey Specification Test for Double-log Regression

```
. ovtest

Ramsey RESET test using powers of the fitted values of lnWaterpercapita

Ho: model has no omitted variables

F(3, 273) = 2.13
Prob > F = 0.0962
```
APPENDIX VII: Stata output for Heteroskedasticity Test for Double-log Regression

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of lnWaterpercapita

\text{chi2}(1) = 0.85
Prob > \text{chi2} = 0.3560